Exhibit 12 Part 4

Attachments H and I to Allocation Recommendation Report (ARR0305-ARR0361)

United States' Motion to Enter Consent Decree,
United States v. Alden Leeds, Inc. et al., Civil Action No. 22-7326 (D.N.J.)

ATTACHMENT H

DIAMOND ALKALI SUPERFUND SITE OU2 ALLOCATION PROTOCOL

Diamond Alkali Superfund Site OU2

Allocation Protocol

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Diamond Alkali OU2
Allocation Protocol

In furtherance of the Allocation Guide and the Revised Work Plan for the Allocation (Task Order #096, Contract EP-W-14-020), this methodology outlines a process for conducting an allocation to determine the relative shares of responsibility among and between the Allocation Parties for the costs for remedial design and remedial action associated with OU2 of the Diamond Alkali Superfund Site. While neither EPA nor the Allocation Parties are bound by the results of the allocation, EPA has committed to use the Allocator's recommended shares of responsibility among the Allocation Parties as a primary factor in its future negotiations in Phase 2 of the ADR Process with the goal of reaching agreement with the Allocation Parties on future cash-out and work party settlements.

Consistent with judicial precedent and customary allocation practice, this cost allocation methodology appropriately considers an Allocation Party's contribution of each COC in OU2 sediments, as weighted by the relative risk each COC poses to human health and the environment, and other relevant equitable factors, in establishing a share of responsibility for each Allocation Party. As deemed feasible and appropriate, the Allocation Team will also establish appropriate tiers of Allocation Party responsibility (i.e., logical groupings of parties with similar allocation responsibility and shares).

Methodology Attributes:

- The allocation shares recommended by the Allocator shall total 100% of the aggregate responsibility of the Allocation Parties[1] as determined during Phase 2 of the ADR Process.

- The Allocation will determine shares of responsibility only for the period of their actual ownership/operation of their OU2 related facility(ies) and/or any additional period for which they have legal liability for the actions of another entity associated with such facility(ies).

- For purposes of this Allocation, shares of responsibility for any contribution of COCs to the OU2 sediments that cannot be attributed to any of the Allocation Parties are in effect distributed among the Allocation Parties on a pro rata basis according to their respective allocation shares.

[1] Allocation Parties refers to all parties notified by EPA as PRPs for OU2 of the Diamond Alkali Site, but does not include the Passaic Valley Sewerage Commission (PVSC), the Cities of Newark, Harrison, East Newark, and Kearney, or parties that entered into an OU2 cash-out settlement with EPA

Diamond Alkali OU2
Allocation Protocol

The following is an outline to the methodology that will be followed by the Allocation Team in conducting the cost allocation regarding OU2. An algorithm incorporating this methodology will be included in the Final Allocation Recommendation Report. This methodology modifies and expands upon the Diamond Alkali OU2 Allocation and Database Design previously issued by the Allocation Team.

Step 1: Establish COC Relative Risk Values

Assign each of the eight COCs an individual Relative Risk Number (COC RRN) determined through an analysis of the relative risk to human health and the environment posed by each COC.

$$\text{COC RRN} = \frac{\text{RRN}}{\text{Sum of RRNs}} \times 100$$

1. Determine the Relative Risk Number for each COC taking into consideration the human health and ecological risk/harm associated with each COC, based on risk data presented in the RI/FFS and ROD, and consistent with the conclusions presented in the RI, FFS, and ROD. The approach for determining the Relative Risk Number for each COC is described in Attachment A.

2. Once the individual COC Relative Risk Numbers are established, conform the values to sum to 100.

Step 2: Establish Allocation Party COC Relative Contribution

Assign a Relative Contribution for each COC (COC RC) contributed by an Allocation Party to OU2 determined as the quotient of the total mass of a COC in OU2 sediments and the mass of the COC contributed by an Allocation Party to OU2 sediments.

$$\text{COC RC} = \frac{\text{CMass}}{\text{TMass}} = \frac{\text{DMass x C\%}}{\text{TMass}}$$

1. Determine the total mass of each COC in OU2 sediment associated with the sediment bed inventory upon which the individual COC Relative Risk Number calculations were based (TMass) in consultation with EPA. The Participating Allocation Parties may provide the Allocator with information they deem relevant to this determination.

2. Determine the mass of each COC contributed by an Allocation Party to OU2 sediments (CMass) as the product of the mass of the COC discharged from an Allocation Party's facility (DMass) and the percentage of COCs discharged from a facility that reached and remain in the OU2 sediments (C%).

   (a) The Allocation Team will determine the percentage of each COC discharged from a facility that reached the OU2 sediments through an analysis of the fate and transport of the COC from the point it discharged from the facility property to reaching OU2 sediments, including consideration of percentage of sewer flow discharged from a CSO or bypass mechanism.

   (b) The Allocation Team will determine the percentage of each COC discharged from a facility that remains in the OU2 sediments through an analysis of the circumstances that affect a COC remaining in OU2 sediment (e.g., navigational dredging, COC solubility).

   (c) Should the Allocation Team determine that the percentage of COCs discharged from an Allocation Party's facility that reached and remain in the OU2 sediments is 0%, or should the Allocation Team determine that the Allocation Party's facility discharges have no nexus to COCs in OU2 sediments, the Allocation Team will forego further analysis of such facility pursuant to this Methodology and assign the Allocation Party a zero share.

   (d) The analysis to determine the mass of a COC discharged from an Allocation Party facility will include consideration of the following factors:

      (1) Nature of the Allocation Party's facility operations

      (2) Facility site-specific features (e.g., location, size, topography, etc.)

      (3) Time period and length of facility operations (e.g., 1932 – 1962 / 30 years)

      (4) Time period and length of any discharges containing a COC (e.g., 1932 – 1962 / 30 years)

      (5) Volume of the discharge and concentration of COCs in discharge

(6) History of facility process waste, sanitary, and stormwater discharges containing any COC, including:

- (i) Pre-discharge treatment, if any;
- (ii) Direct discharges to the Passaic River (e.g., from pipes, trenches, etc.);
- (iii) Discharges to municipal sewers (e.g., the PVSC system, etc.) resulting in discharges to the Passaic River, including via a combined sewer overflow (CSO) or bypass of a sewerage treatment facility;

(7) Concentrations of COCs present in a facility's intake water attributable to municipal water supply or otherwise unrelated to facility operations;

(8) Substantial actions of an Allocation Party that caused migration of COCs in soils of a facility site via groundwater or rainwater (e.g., placement of fill material, a spill, drum burial, disturbance of contaminated soil without appropriate protections, etc.) The migration of COCs deposited with historic fill as designated and/or defined by the State of New Jersey, or as accepted by the State of New Jersey (subject to review for relevancy for the specific facility by the Allocator), in undisturbed soils of a facility site via the natural flow of groundwater or rainwater will not be considered in determining the mass of a COC discharged from an Allocation Party facility; and,

(9) Deductions of amounts of COCs discharged or released that are determined by the Allocation Team to be attributable to releases excluded under CERCLA. The Allocation Team shall make such a determination upon the specific request of an Allocation Party for an evaluation of the probability that the Allocation Party would prevail in the assertion of a legal defense to its liability for certain discharges or releases of COCs from its facility. (e.g., a discharge or release is subject to the petroleum exclusion, the federally-permitted release defense).

(e) Where the Allocator determines that a lack or the nature of available information does not allow an objective determination of the mass of a COC discharged from an Allocation Party facility, the Allocator may take additional measures to obtain relevant information, including requesting additional information from the Allocation Party or requesting the assistance of EPA in obtaining additional data. Should

these measures, if taken, not resolve the lack or nature of available information, the Allocator may estimate such mass utilizing a set of assumptions established in consensus with the Allocation Parties, which assumptions will be described in the Final Allocation Recommendation Report. If used in recommending an Allocation Party's share, the Allocator will explain which assumptions were relied upon and how they factored into his analysis. Such assumptions may include, but not be limited to:

(1) Standard operations of similar industrial facilities;
(2) Changes in industrial operations over time;
(3) Onsite fate and transport of COCs; and
(4) Strength of available information.

(f) The determination of the Allocator regarding the need to use assumptions to estimate the mass of a COC discharged from an Allocation Party facility will be rebuttable upon an evidentiary showing by an Allocation Party to the satisfaction of the Allocator.

3. Divide the mass of the corresponding COC contributed by an Allocation Party to OU2 sediments by the total mass of each COC in OU2 sediment to determine the RC for each COC contributed by an Allocation Party to OU2.

Step 3: Establish Allocation Party Base Scores

Assign a Base Score to each Allocation Party (AP BS) determined as the sum of the products of the COC Relative Risk Number and COC RC for each COC discharged from the Allocation Party's facility.

COC BS = COC RRN x COC RC
AP BS = Sum of AP COC BS^s

1. For each COC discharged by an Allocation Party facility, multiply the COC Relative Risk Number and the COC RC to determine the COC-specific Base Score of that COC (COC BS).

2. Add all of the Base Scores for each of the COCs discharged by the Allocation Party to determine the Allocation Party's Base Score.

Step 4: Establish Adjusted Allocation Party Base Scores

Assign an Adjusted Base Score to each Allocation Party (AP ABS) determined as the sum of the Allocation Party's Base Score and the factors for culpability and cooperation established for the Allocation Party.

AP ABS = AP BS + CUF + COF

1. Establish for each Allocation Party a Culpability Factor (CUF) that addresses the level to which the Allocation Party's contribution of COCs to OU2 sediments were the result of culpable conduct.

   a. Culpable conduct refers to the release or discharge of COCs in contravention of prevailing industrial standards and practices, either (i) knowingly and with intent to skirt environmental regulatory obligations, and/or (ii) with conscious awareness that the release or discharge of COCs were illegal or posed substantial risk to human health or the environment.

   b. Depending on the nature, extent and/or impact of an Allocation Party's culpable conduct, each Allocation Party will be assigned a numerical Culpability Factor equivalent to 0% to 100% of its Base Score, escalating with the level of culpability.

2. Establish for each Allocation Party a Cooperation Factor (COF) that indicates the level to which the Allocation Party cooperated with or failed to cooperate with federal and state authorities in addressing the contamination of OU2.

   a. An Allocation Party's cooperation or failure to cooperate with federal and state authorities in addressing the contamination of OU2 shall be determined through consideration of actions by the Allocation Party, including but not limited to, the following:

      (i) Response to request from a federal or state authority to undertake or fund remedial activities; or
      (ii) Response to request from other Allocation Parties to join in an effort to undertake or fund remedial activities.

   b. Depending on the nature, extent and/or impact of an Allocation Party's cooperation or failure to cooperate, each Allocation Party will be assigned a positive or negative numerical Cooperation Factor

equivalent to plus or minus 0% to 20% of its Base Score, depending upon the level of cooperation or noncooperation.

3. For each Allocation Party, add the Allocation Party's Base Score to its Culpability Factor and Cooperation Factor to determine the Allocation Party's Adjusted Base Score.

Step 5: Establish the Allocation Share of each Allocation Party

The Allocation Share (AS) of each Allocation Party will be determined as the product of 100 and a value equal to the quotient of the Allocation Party's Adjusted Base Score and the sum of all Allocation Party Adjusted Base Scores.

$$\text{AP AS} = \frac{\text{AP ABS}}{\text{Sum of ABSs}} \times 100$$

1. Total the Adjusted Base Scores of all Allocation Parties (Sum of ABSs).

2. For each Allocation Party, divide the Allocation Party's Adjusted Base Score by the Sum of ABSs and then multiple by 100 to determine the Allocation Party's Allocation Share.

Step 6: Establish Allocation Tiers

Assign each Allocation Party to an Allocation Tier that reflects the similarity of its relative responsibility to that of other Allocation Parties.

As deemed feasible and appropriate by the Allocation Team, establish appropriate tiers of Allocation Party responsibility based on a consideration of the relative relationship and natural grouping of the Allocation Parties' Allocation Shares.

Diamond Alkali OU2
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List of Acronyms

AP ABS - Adjusted Base Score assigned to each Allocation Party
AP BS - Base Score assigned to each Allocation Party
AS - Allocation Share assigned to each Allocation Party
CMass - Mass of each COC contributed by an Allocation Party to OU2 sediments
COC BS – Base Share assigned each COC discharged from a facility
COC RC - Relative Contribution of each discharged COC to OU2 sediments
COC RRN - COC Relative Risk Number
COF – The Cooperation Factor assigned to each Allocation Party
CUF – The Culpability Factor assigned to each Allocation Party
DMass - Mass of each COC discharged from an Allocation Party's facility
TMass - Total mass of each COC in OU2 sediments

Attachments

Attachment A – Methodology for Determination of the Relative Rank of OU2 Contaminants of Concern for the Purpose of the Allocation

ATTACHMENT A

Methodology for Determination of the Relative Rank of OU2 Contaminants of Concern for the Purpose of the Allocation

Diamond Alkali Superfund Site
OU2 Allocation

Methodology for Determination of the Relative Rank of OU2 Contaminants of Concern for the Purpose of Allocation

Provided by:

David C. Batson, Allocator

AlterEcho

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ACRONYMS AND ABBREVIATIONS

2,3,7,8-TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
BMI	Benthic macroinvertebrates
CBR	Critical Body Residue
CSM	Conceptual Site Model
COCs	Contaminants of Concern
CTE	Central Tendency Exposure
DDT	Dichlorodiphenyltrichloroethane
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethylene
DDx	Includes six isomers of DDT and its breakdown products DDD and DDE
ERA	Ecological Risk Assessment
FFS	Focused Feasibility Study
HHRA	Human Health Risk Assessment
HQ	Hazard Quotient
HI	Hazard Index
HPAHs	High molecular weight polycyclic aromatic hydrocarbons
LPRSA	Lower Passaic River Study Area
LOE	Line of Evidence
LPAHs	Low molecular weight polycyclic aromatic hydrocarbons

LOAEL	Lowest Observed Adverse Effect Level
NOAEL	No Observed Adverse Effect Level
PCBs	Polychlorinated biphenyls
RME	Reasonable Maximum Exposure
ROD	Record of Decision
TEQ	Toxicity Equivalent Quotient
USEPA	U.S. Environmental Protection Agency

1.0 INTRODUCTION

This document presents an approach to relatively rank contaminants of concern (COCs) based on their contribution to total Environmental Harm ("Percent Contribution to Environmental Harm"). The approach aggregates the endpoints for human health (carcinogenic risk and noncarcinogenic hazard) together with ecological hazard within the lower 8.3 miles of the Lower Passaic River Study Area (LPRSA) (Operable Unit 2 or [OU2] of the Diamond Alkali Superfund Site). This approach incorporates the lines of evidence (LOEs) used to characterize human health and ecological risk and hazard as presented within the U.S. Environmental Protection Agency's (USEPA's) Remedial Investigation and Focused Feasibility Study (RI/FFS) for OU2 (Louis Berger et al., 2014), as well as in the 2016 Record of Decision for OU2 (OU2 ROD) (USEPA, 2016). This approach to rank COCs based on their contribution to total Environmental Harm is only for the OU2 allocation. While this approach relies on the human health and ecological risk assessments performed for OU2 of the Site, it is not a risk assessment itself. The relative risk each COC poses to human health and the environment, along with an Allocation Party's contribution of each COC in OU2 sediments and other relevant equitable factors, will be used to establish a share of responsibility for each Allocation Party in the OU2 allocation.

Human health is represented here by the receptor/exposure combinations that drove risk in the Human Health Risk Assessment (HHRA) in Appendix D of the RI/FFS (Louis Berger et al, 2014); specifically, the exposure of adults and children (e.g., anglers) via ingestion of self-caught fish and crab muscle and hepatopancreas tissue. These calculations are based on site-specific COC exposure data and regulator-approved toxicity values.

Ecological health implications are predicated on the consideration of RI/FFS Ecological Risk Assessment (ERA) endpoints (Appendix D of the RI/FFS). ERA endpoints (survival, growth, and reproduction effects on fish, crab, benthic invertebrate, and wildlife species) provide separate preliminary LOEs for the allocation process and incorporate a complete assessment of ecological hazard to important components and organisms of a functioning tidal riverine ecosystem. The range of ecological LOEs reflects the unique attributes and types of COC sensitivities among a diverse assemblage of organisms assessed in the RI/FFS ERA. Ecological LOEs are supported by a complete set of site-specific COC exposure data and toxicity benchmarks associated with sustainability of the LPRSA riverine ecosystem.

1.1 Framework

An allocation that accounts for both human and ecological harm requires an evaluation of the relative contribution of each COC to the need for, and scope of, remedial action. There are inherent challenges in developing a methodology that aggregates the disparate endpoints of risk and hazard into a single value for each individual COC. The human health endpoints (carcinogenic risk and noncarcinogenic hazard) and ecological endpoints are not cumulative and represent very different health effects bases and potential outcomes. The overall framework the Allocator has chosen to represent the human health and ecological implications of site-related contamination is to develop indicators of Percent Contribution to overall Environmental Harm reflecting both human and

ecological receptors. These calculations are explained in more detail below and in Sections 3 and 4 of this document. The overall Environmental Harm framework is intended to incorporate the RI/FFS human health and ecological risk assessments, which drove remediation plans for OU2. However, a small number of modifications were made where necessary to strengthen the foundation of the Environmental Harm approach. In any of these instances, the analysis attempts to conform to the RI/FFS approach to the greatest extent possible. For example, additional USEPA-approved background data and updated exposure and toxicity values that reflect current scientific knowledge were used. For transparency, any deviations from the RI/FFS are clearly spelled out in this text and/or in attached tables.

Much of this document discusses the details of the human health and ecological inputs to "Percent Contribution to Environmental Harm". Interim calculated values include "percent contribution to human health hazard" or percent contribution to human health risk" (two distinct human health indicators) and "percent contribution to ecological harm or hazard" (a single indicator), which are mathematically distinct from, and component inputs to, "Percent Contribution to Environmental Harm".

In the context of traditional human health risk assessment, individual risks or hazard quotients (HQs) may be summed to develop estimates of cumulative risk and a hazard index (HI). However, this allocation must go beyond EPA risk assessments and account for the overall "Environmental Harm" associated with three separate indicators, namely human health risk, human health hazard and ecological hazard. This document presents a model for accomplishing this aggregation. To do this, individual contaminant-specific quantitative point estimates of risk and hazard are viewed in light of their percent contribution to human health hazard or risk or ecological harm or hazard as an indicator of influence on gross health and environmental effect, herein characterized as Environmental Harm.

To aggregate the three indicators (i.e., human health risk, human health hazard and ecological hazard) and develop the final Percent Contributions to Environmental Harm for each COC, the following step-wise process was used:

1. Percent contributions to human health risk for each COC were developed, as were percent contributions to human health hazard for each COC;

2. COC-specific percent contributions to ecological hazards from seven lines of evidence were averaged across all LOEs to produce percent contribution to ecological harm; and then

3. For each COC, percent contribution to human health cancer risk, percent contribution to human health hazard and percent contribution to ecological harm were averaged, yielding Percent Contributions to Environmental Harm.

This three-input approach is consistent with that taken in the ROD to develop the remedy for the LPRSA. The Percent Contribution to Environmental Harm for each COC provides a relative

ranking for allocation purposes based on percent contribution to human health cancer risk, percent contribution to human health hazard and percent contribution to ecological harm for all relevant lines of evidence. The decision to average the contribution of each COC across the three indicators is based on the foundational assumption that human health cancer risk, human health hazard, and ecological hazard are equally important considerations in EPA's remedial decision-making process and this allocation.

Throughout the calculations, where a component value is zero (0), that zero is used directly in the averaging process. For example, for a chemical that is a COC for ecological receptors but not for human health, that chemical's percent contribution for human health is zero. To fairly represent the overall Percent Contribution to Environmental Harm for that chemical, the human health and ecological components (zero and a non-zero value) are averaged. This approach is predicated on the notion that actual risks for non-COCs might be infinitesimally small and zero represents a fair measure of respective contaminant contributions to overall Environmental Harm. This approach is also faithful to the foundational assumption of equivalency in social value and importance between human health and ecological harm and recognizes differences in sensitivity to the COCs among the human and ecological receptors.

1.2 Contaminants of Concern

Contribution to Percent Contribution to Environmental Harm is based on the percent contribution of each of nine COCs to risk characterization totals, based on selected human health exposure scenarios and ecological receptor functional groups presented in the RI/FFS. The COCs that are relatively ranked in this model were identified in Section 5.2 of the ROD as posing "the greatest potential risks to human health and the environment" and ultimately used to select the remedy to address contaminated sediments in OU2 (USEPA 2016). Respective COCs are listed below:

- Copper – ecological COC
- DDx – human health and ecological COC (includes six isomers of dichlorodiphenyltrichloroethane (DDT) and its breakdown products dichlorodiphenyldichloroethane (DDD) and dichlorodiphenyldichloroethylene (DDE). For human health, only 4,4-DDD, 4,4-DDE, and 4,4-DDT are COCs.)
- Dieldrin – human health and ecological COC
- Dioxins and furans (2,3,7,8-TCDD or TCDD toxicity equivalents) – human health and ecological COC
- High-molecular-weight polycyclic aromatic hydrocarbons (HPAHs) – ecological COCs
- Lead – ecological COC
- Low molecular weight polycyclic aromatic hydrocarbons (LPAHs) – ecological COCs

- Mercury – human health and ecological COC
- Polychlorinated biphenyls (PCBs) – human health and ecological COC

The ROD presents human health risk and hazard calculations for three COCs for which human health preliminary remediation goals (PRGs) were derived: TCDD-TEQ, total PCBs, and methyl mercury] (USEPA 2016). For the COCs DDx and dieldrin, which were presented as human health risks and hazards in the FFS HHHRA but not in the ROD, human health risks and hazards were calculated by the Allocator using the updated ROD exposure assumptions. Copper, lead, and PAHs were not included as COPCs in the HHRA for the FFS Study Area, and therefore no human health risks are associated with these constituents for the purpose of the Allocation.

During review of data used for the ERA, it was discovered that one sediment sample that USEPA intended to remove from the sediment exposure dataset was inadvertently included. This sample (LPRT03G) was collected from the Lister Ave Phase I Dredge Area. At the time during OU2 ROD development when the anomaly was discovered, the Louis Berger et al. (2014) RI/FFs was already finalized. USEPA determined that inclusion of the LPRT03G sample results would have had minimal effect on the exposures evaluated in the BERA and would not have affected overall risk conclusions sufficiently to warrant revising RI/FFS risk assessments. To ensure use of the most relevant and current data, the LPRT03G sample results were removed from respective exposure estimates for the purposes of the current evaluation. This revision only affects the site DDx sediment exposure estimate concentration, resulting in a change from 260 mg/kg to 180 mg/kg.

1.3 Background Exposure Considerations

Risk and hazard estimates, as presented in this approach, represent OU2 (non-background) and incremental quantitative point estimates. Incremental quantitative point estimates represent adjusted values based on the site-related contribution to the system, where relevant, and negate contributions from naturally-occurring and anthropogenic background sources. The Passaic River, above Dundee Dam, has been identified by the USEPA as indicative of background conditions for OU2. The background environmental media included in the calculations for percent contribution are fish tissue, crab tissue, and sediment. Where background concentrations for a specific COC in a specific medium exceed site-related concentrations (e.g., dieldrin in fish tissue for human health), that COC is assumed to have site-related HI and cancer risk of zero and therefore a percent contribution to human health harm of 0%.

Fish Tissue Concentrations: In the absence of actual background fish tissue data, USEPA's RI/FFS estimated background contributions by modeling tissue concentrations in fish based on USEPA's estimated background concentrations of COCs in sediment (Appendix A, Data Evaluation Report No. 6 of the RI/FFS). Since that time, additional background data have been collected as part of the remedial investigation and feasibility study for OU4 of the Site, including fish tissue data suitable for inclusion in human health risk-related calculations. These new background fish tissue data are used in the percent contribution to human health and ecological

harm calculations, because empirical (measured) data for fish tissue is more accurate than would be a calculated estimate. Furthermore, the RI/FFS developed estimated tissue concentrations for a limited number of fish species. The more recent, empirical dataset included measured tissue concentrations for a greater number of species, including species that were part of the mixed fish diet evaluated in the RI/FFS HHRA and the generic fish evaluated in the RI/FFS ERA. The same risk models used in the RI/FFS were used to calculate risk from background in this model, with the exception that the empirical fish data were substituted for the modeled values.

Crab Tissue Concentrations: Similar to background fish tissue estimates, the RI/FFS estimated concentrations of COCs in blue crab tissue (see Appendix A, Data Evaluation Report No. 6 in the RI/FFS). The geographic area (above Dundee Dam) used to collect newer background samples does not include habitat suitable for blue crabs. Because it was not possible to obtain empirical crab background crab tissue data, modeled crab data from the RI/FFS were used in percent contribution calculations.

Sediment Concentrations: The RI/FFS used and reported background surficial sediment data collected in fall 2008 (AECOM, 2014). Additional background sediment data were collected for the remedial investigation and feasibility study for OU4 of the Site in fall 2012. Fall 2012 and fall 2008 surficial sediment sampling were conducted using the same methods. Therefore, both datasets can be reasonably combined which substantially increases the number of background samples (18 samples vs. 58 total samples) available for this analysis. The combined 2008/2012 dataset has been approved for use by USEPA and is currently being used to evaluate Operable Units upriver from OU2. The combined 2018/2012 background sediment dataset is used to derive background exposure estimates herein.

Incorporation of Background: The human health and ecological calculations of percent contribution to both human health and ecological overall Environmental Harm are adjusted for background contamination exposure risks and hazards. For both human health and ecological evaluations and for each COC in each environmental medium (fish tissue, crab tissue, and sediment) both OU2-related and background human health hazard and cancer risk and ecological hazard were calculated. Background hazard and risk results were subtracted from OU2 results, yielding incremental (site-related) LOE results (human health hazard indices and cancer risks, and ecological hazards). These incremental (site-related) results were used to develop LOE-specific percent contributions to human health hazard and risk and percent contributions to ecological hazard. For transparency, supporting tables provide OU2-specific, background-specific, and incremental risk/hazard calculations and results.

2.0 HUMAN HEALTH ASSESSMENT

This section describes the human health inputs to develop Percent Contribution to Environmental Harm. The goal of this human health assessment is to objectively evaluate LOEs used to characterize risks to humans associated with site-related contamination. Percent contribution to human health risk and hazard calculations are provided in Attachment A Supporting Tables A-1 through A-5, herein.

Our primary evaluation objective is to incorporate results of a complete and defensible assessment of the human health risks associated with the human health COCs (see Section 1.2) that is consistent with OU2 RI/FFS and ROD remedy selection methodology.

While the Conceptual Site Model (CSM) for the RI/FFS HHRA (Louis Berger et al., 2014) considered current and future conditions in the lower 8.3 miles of the LPRSA to describe the magnitude and range of exposure by various receptors and age ranges (i.e., adults, adolescents and children), the only pathways of exposure evaluated quantitatively in the RI/FFS HHRA were the consumption of self-caught fish or crab from OU2 by an adult angler/sportsman and other family members. Consistent with USEPA guidance, the RI/FFS HHRA evaluated risks using both a reasonable maximum exposure (RME) and a central tendency exposure (CTE) condition to describe the magnitude and range of exposure that might be experienced by the aforementioned receptors (i.e., angler and family members).

Cancer risk and noncancer hazard estimates associated with an angler's ingestion of self-caught fish and crab formed the basis for the human health risk characterization. Only those estimates associated with the RME condition were used in this model as inputs to Percent Contribution to Environmental Harm.

Consistent with USEPA HHRA Guidance, the RI/FFS HHRA uses mathematical equations to incorporate information and assumptions about:

- COC concentration in the exposure medium (edible fish and crab tissue)
- COC toxicity (Cancer slope factors and noncancer reference doses)
- Receptors (such as age and body weight of adults and children who consume self-caught fish and crab)
- Intake of the exposure medium (quantity of self-caught fish and crab tissue ingested by children and adults)

This mathematical equation results in two indicators of the potential for adverse health effects to occur in humans as a result of the specific exposure to specific COCs. The two indices are the hazard quotient (one COC and exposure pathway) or HI (multiple COCs and exposure pathways), and the excess lifetime cancer risk or risk. HIs or risks can be summed across chemicals and exposure routes (although in this case ingestion is the only exposure route considered). It should be noted that these indicators of toxicity are not summed with each other in traditional risk assessment because in that context they are not commensurable. For the purposes of the allocation, the cancer risks and hazard indices (HIs) are used to develop two separate indicators: percent contribution to human health risk and percent contribution to human health hazard for each COC. The allocation requires an evaluation of the relative contribution of each COC to overall Environmental Harm and in that respect must go beyond the objectives of a traditional risk assessment in which hazard and risk are considered separately from each other. Thus, in the next

step of the risk methodology process for this allocation, the percent contributions from hazard index and cancer risk are combined with percent contribution to ecological harm (Section 3) in a three-way average for each COC to produce Percent Contribution to Environmental Harm for each COC.

For human health, consistent with evaluations conducted in the RI/FFS and the ROD, PCBs are evaluated as total PCBs, using the cancer and non-cancer toxicity factors used in the FFS HHRA to evaluate non-dioxin-like PCBs. USEPA made the decision in the RI/FFS and ROD to develop PRGs based on total PCBs only.

Most toxicity values are the same as those in the HHRA (Tables 4-11 and 4-12 of Attachment 4 to Appendix D of (Louis Berger et al., 2014). However, with the passage of time since the HHRA was completed, the toxicity values for DDD and DDE have been updated by USEPA (2017a, b), and those are included in our calculations and can be identified through footnotes in the attached calculation tables. Similarly, as footnoted in the calculation tables, adult body weight and exposure duration are updated herein to reflect current USEPA (2014) guidance.

3.0 ECOLOGICAL ASSESSMENT

This section describes the ecological inputs to develop Percent Contribution to Environmental Harm. This includes a description of each ERA LOE used to support the allocation procedure. Percent contribution to ecological hazard calculations are provided in Attachment A Supporting Tables A-6 through A-13, herein.

Our primary evaluation objective is to base Percent Contribution to Environmental Harm OU2 on ecological community risks from exposure to nine COCs (see Section 1.1). The ecological community approach is consistent with the problem formulation analysis presented in Section 7.2.1 of the OU2 ROD (USEPA, 2016). The final assessment approach considers risk contributions for representative ecological receptors from low trophic-level foundational prey species to high trophic-level predatory species. This approach recognizes that a functioning ecosystem is comprised of a diverse assemblage of organisms that are dependent on one another to transfer energy and production of ecological benefits up the riverine food chain. This approach also accounts for the differences in the range of sensitivity or toxicity to COC exposures among different ecological receptors, while assuming that each representative receptor is of equal value and importance to the ecosystem.

Similar to the human health assessment described in Section 2.0 above, the current ecological assessment of PCB risks are evaluated as total PCBs and not as separate total PCB and coplanar PCB risks. This methodology is consistent with the treatment of and separation of PCB risks from dioxin/furan or TCDD toxicity equivalents risks during OU2 remedy selection (USEPA, 2016). Assessment of total PCBs risks also increases the comparability of LOEs in which coplanar PCB risks cannot be evaluated; e.g. invertebrate sediment exposure.

The primary source of ERA information is the *Lower Eight Miles of the Lower Passaic River Risk Assessment* found in Appendix D in Louis Berger et al. (2014) RI/FFS; hereby referred to as the RI/FFS ERA. As described in Section 1.3 of this report, additional background fish tissue and sediment data not used in the RI/FFS ERA are used to derive incremental risks herein. The current evaluation uses additional ERA methods to refine RI/FFS ERA LOEs. These methods are consistent with those currently being used to conduct ERAs in OUs upriver from OU2 and use of ERA results during remedy selection in the OU2 ROD (USEPA, 2016). Specific methodology refinements are described in subsequent sections of this document and identified in attached calculation tables.

3.1 Ecological Risk Lines of Evidence

The RI/FFS ERA evaluates COC exposure risks to the OU2 ecological community using seven separate assessment LOEs. The LOEs are based on risk characterization results for species or groups of species that contribute to key ecological functions in the OU2 ecological community. Seven LOEs are available to determine if OU2 habitats can support survival, growth, and reproduction and are specific to benthic macroinvertebrates (BMIs), crab, detritivorous, insectivorous, and piscivorous fish, and aquatic birds and associated riverine system mammals. We describe each of the seven RI/FFS ERA LOEs in the following summaries.

3.1.1 Sediment-based direct exposure macroinvertebrate assessment

BMIs are small aquatic insects, crustaceans, and worms that play a key role in nutrient and energy transfer in riverine ecosystems. They also process and assimilate organic material, feed on other invertebrates, and are themselves consumed by fish and wildlife. BMIs reside and forage in and on in-river substrates, including contaminated sediments. As such they are in direct contact and have high exposure potential to sediment-based contamination. Oysters are also considered for this LOE. Oysters provide forage and reef habitat for other invertebrates and many fish species. They are exposed to sediment-based contamination when filtering suspended sediments from the water column. If great enough, contamination can have direct negative consequences to BMI communities. These consequences include eradication of sensitive taxon, formation of a community dominated by pollution tolerant taxon that readily bioaccumulate contaminants, and reduction of prey for dependent species. Inclusion of macroinvertebrate risks into this allocation procedure provides an ecological metric representing localized risks from OU2 sediments to a foundational component of the riverine ecosystem.

Given their exposure potential and sensitivity to a wide range of contaminants, BMIs are often used to assess ecological health. As such, there is a large base of toxicity information available to support BMI risk characterization based on direct exposure to contaminated sediments. The RI/FFS ERA compares site-specific and literature-based, direct sediment exposure toxicity benchmarks to site sediment concentrations to evaluate risks to BMIs. This is done for each of the nine COCs evaluated in the ERA (TCDD, total PCBs, mercury, total DDx, copper, dieldrin, HPAHs, LPAHs, and lead). Sediment exposure estimates were obtained from a relatively large dataset of contaminants measured in OU2 surficial sediments. With exception of TCDD, toxicity

values evaluated herein represent upper bound or lowest observed adverse effect levels (LOAELs). The RI/FFS ERA uses a lower bound toxicity sediment benchmark for TCDD to evaluate BMI risks. This TCDD benchmark is specific to oysters which are an important foundational invertebrate species in the region. The current analysis uses this same toxicity benchmark when characterizing BMI risks from sediment-based TCDD exposure.

3.1.2 Tissue-based crab assessment

Blue crab are locally abundant macroinvertebrates that are considered keystone species in eastern seaboard bay and estuarian habitats. Benthic juveniles and adults consume and cycle energy from bivalves, other crustaceans, fish, marine worms, plants, and detritus to higher trophic-level organisms such as predatory fish and humans. Crab larvae are planktonic and provide prey for many important fish species, especially early life stage fish that are dependent on them for subsistence. In addition to bioaccumulating contaminants from water and sediment, all life-stages of blue crabs can be sensitive to contamination.

Inclusion of blue crab risks into this allocation procedure provides an ecological metric representing a mobile, ecologically and commercially important species that has high potential to assimilate contaminants from LPRSA habitats.

The RI/FFS ERA evaluates crab risks using a crab tissue-based critical body residue (CBR) approach. This approach is focused on measuring contaminants in crab tissues and comparing results to tissue-based toxicity benchmarks obtained from a toxicity literature base. This approach assumes that contaminants accumulated in crab tissue can be directly toxic to a crab or detrimental to young when maternally transferred into eggs. The RI/FFS ERA selected CBRs for each of the nine COCs that are associated with adverse effects to survivorship, growth, and reproduction to crab. CBRs are directly compared to COC concentrations measured in blue crab tissues collected throughout OU2. The current analysis uses this same approach to assess risks to crab.

3.1.3 Tissue-based forage fish assessment

Forage fish is a term used to describe small minnow-like fish that provide an important prey base to piscivorous fish and riverine wildlife. Forage fish are important primary consumers in the aquatic food chain that transfer energy from small invertebrates, plant material, and plankton to higher-level consumers. Mummichog is a small killifish that is native to and locally abundant in the LPRSA. Forage fish can be exposed to site contamination via direct contact with water and sediments and consumption of contaminated sediment and prey, such as benthic invertebrates that have accumulated contaminants from the environment. Forage fish can also assimilate contaminants in their tissues, often at levels above those in their diet. This is especially relevant when fish are exposed to lipophilic organic contaminants with high bioaccumulation potential. Accumulated contaminants can be directly toxic to the individual fish or developing embryos and young when maternally transferred.

Inclusion of forage fish risks into this allocation procedure provides an ecological metric representing a locally abundant and ecologically important species that has high potential to accumulate contaminants from LPRSA contaminated habitats. Reduced populations of forage fish can impact higher trophic-level species such as larger predatory fish and piscivorous birds that rely on them for subsistence. Their absence can also unbalance the riverine ecosystem and result in hazardous conditions to humans if macroinvertebrate prey items such as mosquitoes are left unchecked.

The RI/FFS ERA evaluates risks to forage fish using COC concentrations measured in site-collected mummichog whole-body tissue samples. Similar to crab, these whole-body contaminant concentrations were compared to tissue-based CBR toxicity benchmarks obtained from the toxicity literature base. Selected tissue-based toxicity benchmarks relate to contaminant concentrations that reduce growth, survival, and reproduction in exposed fish. Tissue concentrations and toxicity benchmarks are available and used to assess forage fish risks for all nine COCs. However, application of CBR-based risk characterization potentially produces overly conservative results for fish exposed to non-organic contaminants such as copper and lead because of the wide range of strategies used by fish species to store, detoxify, and excrete bioaccumulated metals (Adams et al. 2011). As such, the current analysis of harm caused by the two metal COCs (copper and lead) is not based on tissue-based CBR approach. Instead, harm to fish from these two metals is evaluated using a dietary modeling-based exposure approach. This is the same approach used to evaluate fish risks for OU4 located upriver from OU2.

Fish dietary modeling involves estimating exposure using dietary exposure parameters (food intake rates and incidental sediment intake rates), diet composition (fraction of each dietary item/prey type such as invertebrates and fish), and concentrations of COCs (copper and lead) in each dietary item. Estimated doses (mg of COC/kg fish body weight/day) are then compared to toxicity benchmarks associated with adverse effects in fish from consumption of metals contaminated diets. Upper (no observed adverse effect level [NOAEL]) and lower bound (LOAEL) toxicity values are available for copper but only one acceptable NOAEL is available for lead. The current analysis uses the dietary exposure NOAEL value when evaluating LPRSA lead exposure risks for forage fish which results in a very low HQ of 0.01 (Table A-11). Given the lack of a LOAEL toxicity benchmark, low LPRSA NOAEL-based HQ, and relative insensitivity of dietary lead exposure in fish, the final percent contribution of lead uses a LOAEL-based HQ of zero for this LOE. This application is also supported by the fact that the background lead sediment concentration (382 mg/kg) is greater than the LPRSA concentration (240 mg/kg) which would likely result on an incremental contribution of 0% for this COC as derived for BMIs (Table A-6).

The dietary exposure scenario assumes that forage fish are exposed to sediment dwelling worms and incidental sediment ingestion. Concentrations of copper and lead in OU2-collected worm tissues and mudflat sediments are available and used to estimate OU2 forage fish exposure. Background (above Dundee Dam) worm tissue sampling has not been conducted. Therefore, concentrations were estimated using average ratio of copper measured in OU2 worms and co-located OU2 sediments which is then applied to background sediment concentrations. Forage

fish dietary modeling calculations are provided in a series of attached tables (Tables A-11 through A-13). Again, the dietary-based risk characterization methods and results were only applied to the two metal COCs (copper and lead) and all other COCs were evaluated using the CBR approach as done in the OU2 RI/FFS ERA.

3.1.4 Tissue-based generic fish assessment

The RI/FFS ERA uses the term "generic fish" to describe all other fish types other than forage fish. We note here that some supporting ERA documents describe this LOE as "piscivorous fish", but this is a misnomer since not all the fish species evaluated are piscivorous. For example, species represented in this LOE include; white perch, American eel, catfish ssp., carp, smallmouth bass, largemouth bass, white sucker, and northern pike. All these fish species occur/could occur in the LPRSA ecosystem. These species fill unique ecological niches and are ecologically, recreationally, and commercially important. For example, white perch and bass are resident, predatory species that keep invertebrate and small fish populations in check and are popular sportfish in the area. Other species such as American eel were once commercially important species that use tidal river habitats and resources for part of their life history cycle.

Bottom feeding detritivores, such as carp and sucker, can be detrimental in large numbers but do play an ecological role in cycling energy from lower to higher trophic level food chains. This diverse assemblage of generic fish species can be exposed to site contamination from direct exposure to water, sediments, and prey that have accumulated contaminants from the environment. Like forage fish, contamination can adversely affect generic fish via direct toxicity and/or be toxic to developing embryos and young when contaminants are maternally transferred. Reductions in generic fish populations can adversely impact energy cycling, fishing opportunities, and piscivorous wildlife species and populations that rely on them as a food source.

Inclusion of generic fish risks into this allocation procedure provides an ecological metric for relevant and locally important fish species in the study area. When analyzed with forage fish, generic fish also provide a complete assessment of the LPRSA fish community.

The RI/FFS ERA evaluates risks to generic fish using COC concentrations measured in site-collected fish tissues. Similar to other tissue-based assessments, whole-body contaminant concentrations were compared to tissue-based toxicity benchmarks obtained from the toxicity literature base. Selected benchmarks relate to contaminant concentrations that reduce growth, survival, and reproduction in exposed fish.

The CBR approach is an integrated and valid assessment technique to characterize reproductive toxicity in fish exposed to site-specific toxic bioaccumulative contaminants. However, as described above, the CBR approach potentially produces overly conservative results for metal COCs (copper and lead). Therefore, dietary-based exposure modeling and toxicity assessments are used to characterize risks to generic fish species exposed to copper and lead. This assessment models exposures for nine fish species so that a wide range of dietary exposure regimes are characterized. Species-specific hazard quotients (HQs) are averaged to obtain a single set of

generic fish HQs for copper and lead for this ERA LOE. Like forage fish assessment for lead exposure, LOAEL-based HQs for lead were assumed to be zero in OU2 and background risk calculations. Again, the dietary-based risk characterization methods and results were only applied to the two metal COCs (copper and lead) and all other COCs were evaluated using the CBR approach.

3.1.5 Dietary-based exposure heron assessment

Blue heron are large wading birds that forage for small fish and invertebrates in shallow waters. In the LPRSA, they can be seasonal or permanent residents. Heron can be exposed to site contaminants via dietary exposure routes; the most important of which include incidental ingestion of sediments and consumption of aquatic prey items, such as forage fish and invertebrates that have accumulated contaminants into their tissues. Aquatic birds, such as heron, can be sensitive to environmental contaminants that can impact reproductive functions. These functions include eggshell thinning and biochemical processes that can lead to underdeveloped offspring, poor egg hatchability, and reduced fledgling fitness and fledging success. All of which can be detrimental to the health and sustainability of local heron populations.

Blue heron is a common assessment species in ERAs. They are often identified as a species that has high exposure to bioaccumulative contaminants. As such, they have a substantial literature base from which to model food chain dietary exposures and estimate toxicity. The RI/FFS ERA estimates heron exposure using readily acceptable food chain model parameters for each of the nine COCs. This includes concentrations of COCs measured in site sediments and tissues of heron prey items, specifically, generic fish collected within OU2. Dietary exposure estimates are compared to COCs concentrations that impact hatchability of bird eggs and survivability of offspring under experimental conditions. Respective toxicity reference values were obtained from a large literature base of readily available sources. Many of these sources are also included in USEPA-approved guidance documents that have been subject to a rigorous screening process to ensure high quality experimental results and subsequent toxicity values. We also note that the RI/FFS ERA evaluates heron risks for a series of exposure scenarios. These scenarios consider whether heron are seasonal or permanent residents; fed on forage fish, generic fish, or crab; and, whether they incidentally ingest sand bar-specific or surface sediments throughout the LPRSA. Risk estimates from the resident heron, generic fish consumption, and site-wide surface sediment exposure scenario are considered herein. This scenario results in the highest heron exposure and risk estimates to all nine COCs. However, all heron exposure scenarios evaluated in the RI/FFS ERA result in relatively similar risk estimates.

Inclusion of blue heron risks into this allocation procedure provides an ecological metric representing a highly exposed, sensitive avian receptor at the top of the aquatic food chain. In addition, heron risks are based on well-established dietary exposure parameters and toxicity reference values and site-specific sediment and fish tissue sample COC concentrations.

3.1.6 Tissue-based herring gull embryo assessment

Herring gull are relatively common aquatic bird species along the Atlantic coast and are often referred to as seagulls. They are omnivorous, opportunistic scavengers and can thrive in a wide variety of aquatic and terrestrial habitats. Gull can have a large foraging range and can travel tens of miles from breeding colonies to find food; although, ranges of over 100 miles have been observed. Like heron, gull can be exposed to site contaminants via ingestion of sediments and aquatic prey that have bioaccumulated site contaminants. Also similar to heron, gull can be sensitive to environmental contaminants which, at great enough concentrations, can elicit similar toxicological responses.

The RI/FFS ERA evaluates herring gull risks using an embryo tissue-based analysis. Since site-specific gull embryo/egg data were not available, a series of biomagnification modeling steps are conducted to estimate embryo/egg COC concentrations. This consisted of obtaining biomagnification information from a cited source for Lake Ontario gull and assumed Passaic River gull would have the same biomagnification potential. Briefly, COC concentrations in Lake Ontario gull fish diet (alewife) and gull eggs are used to derive fish diet-to-gull egg biomagnification factors. These fish diet-to-gull egg biomagnification factors are then applied to OU2-collected forage fish tissue COC concentrations to estimate concentrations of COCs in Lower Passaic River gull eggs. These estimated concentrations are then compared to literature-based, egg tissue toxicity reference values that correspond to reduced reproduction in various bird species. The RI/FFS ERA evaluates four of the nine COCs for this line of evidence: dieldrin, total DDx, total PCBs, and TCDD (dioxins and furans only). Addition of remaining COCs is not possible because underlying data needed to derive respective fish diet-to-gull egg biomagnification factors are not available.

Risks from the RI/FFS ERA tissue-based herring gull embryo assessment are included in the current allocation procedure. Gull are identified as an important ecological receptor in the beginning problem formulation step of the RI/FFS ERA. Gull embryo assessment results are also specifically considered in the OU2 ROD problem formulation assessment (Section 7.2.1) to assess exposures to sensitive early life stage receptors and when developing the sediment-based preliminary remediation goal for DDT (Table 20 in USEPA, 2016). It is important to note that both heron and herring gull are included as separate LOEs in the RI/FFS ERA and herein. The two avian wildlife species occupy unique ecological niches and respective reproductive risks are evaluated using two very different assessment methods. Therefore, inclusion of gull embryo risks in this allocation procedure does not constitute double counting of risks associated with aquatic bird COC exposures and is somewhat analogous to use of forage vs. generic fish LOEs.

3.1.7 Dietary-based exposure mink assessment

Mink are small, semiaquatic carnivorous mammals. They prey upon small mammals, crustaceans (such as crab), amphibians, and birds, but fish are often their most important source of food in riverine habitats. They have relatively small forage ranges for most of the year and are considered residents in locations where they occur. Therefore, mink are expected to forage throughout the

year in the LPRSA. Laboratory and field studies have shown that mink can be quite sensitive to environmental contamination. Being a top predator with small forage areas, mink also have great potential to be highly exposed to bioaccumulative contaminants that biomagnify within local aquatic food chains. These attributes make mink an ideal species to monitor and assess environmental contamination. As such, they are a common laboratory toxicity test species and are often included in ERAs.

Mink are included in the RI/FFS ERA to represent a sensitive aquatic mammal. Like blue heron, mink dietary exposure risks are assessed using a food chain analysis. The RI/FFS ERA estimates mink exposure using readily acceptable food chain model parameters for each of the nine COCs. This includes concentrations of COCs measured in site sediments (incidental ingestion) and tissues of mink prey items; specifically, forage fish (80% of total diet) and crab (20% of total diet) tissue data collected within OU2. Dietary exposure estimates are compared to toxicity reference value COC concentrations that impact mink reproduction under experimental conditions.

Inclusion of mink risks into this allocation procedure provides an ecological metric representing a sensitive mammalian receptor at the top of the food chain that is expected to be highly exposed to site-specific COCs. In addition, risks estimates are based on well-established dietary exposure parameters, toxicity reference values, and site-specific sediment, fish tissue, and crab tissue sample contaminant concentrations.

4.0 RESULTS

This section presents the Percent Contribution to Environmental Harm results for human health and ecological components. Results of the final, aggregated (human health with ecological) Percent Contribution to Environmental Harm are also summarized. All supporting calculations are provided in tables attached to this document.

4.1 Percent Contribution to Human Health Hazard and Risk

Table 1 (Attachment A) presents site-related risk and hazard point estimates associated with fish and crab tissue ingestion, together with each COC's percent contribution to human health risk and hazard. Hazard estimates reflect potential elicitation of non-cancer effects, based on exposure of a child. Risk estimates reflect probabilities of cancer development, based on age-adjusted exposures, accounting for childhood and adult exposures.

It is important to note that for dieldrin, newer sediment background concentration exceeded concentration in site sediment (background > OU2). However, the modeled background dieldrin concentration in crab was lower than site measured crab tissue concentration (background < OU2). This may be an artifact of not remodeling background crab dieldrin concentration using new sediment background data. The model used to estimate crab tissue concentrations from sediment requires inputs for sediment organic carbon content; these data are unavailable.

As seen in Table 1, dioxin (represented as TCDD TEQ, dioxins/furans) drives both the fish ingestion- and crab ingestion-based incremental hazard estimates. Fish diet-based incremental hazard (107.85) represents 75% of the pathway-specific hazard (percent contribution to human health hazard) and crab diet-based hazard (49.61) represents 89 percent contribution to human health hazard. These values are averaged to develop the percent contribution to human health incremental hazard for dioxins of 81.99. Dioxins are the biggest contributor to the human health component of Percent Contribution to Environmental Harm. Averaged incremental percent contributions to human health hazard are as follows:

- Dioxin: 81.99%
- Total PCBs: 16.79%
- Mercury: 0.63%
- DDx: 0.55%
- Dieldrin: 0.03%

Likewise, dioxin drives the incremental percent contribution to human health risk for both the fish and crab diet-based LOEs. Fish diet-based risk (2.80E-03) represents 89% of the pathway-specific percent contribution to human health risk and crab diet-based risk (1.29E-03) represents 96% of the pathway-specific percent contribution to human health risk. These values are averaged to develop the overall percent contribution to human health risk for dioxins of 92.24%. Averaged percent contributions to human health risk are:

- Dioxin: 92.24%
- Total PCBs: 7.40%
- Dieldrin: 0.26%
- DDx: 0.10%

From a purely pragmatic perspective, and to judge whether one LOE is eliciting a greater influence on the expression of magnitude of impact, one can consider the hazard and risk point estimates associated with the major contributor, dioxin. The hazard quotient associated with dioxin from ingestion of fish is 108, which is roughly two orders of magnitude above unity, the traditional EPA criterion for acceptability. The risk estimate associated with dioxin from fish ingestion is 2.80E-03. This value is approximately two orders of magnitude above the mid-point of the National Oil and Hazardous Substances Pollution Contingency Plan Relative Risk Range of 1E-05. While risk is the probability of incurring a carcinogenic response and is presumed to be linear, there is no linear relationship between hazard quotient and effect. In spite of this, there is reasonable agreement between the magnitudes associated with potential health impact based on both data lines.

4.2 Percent Contribution to Ecological Hazard

Table 2 (Attachment A) presents site-related ecological hazard quotient point estimates associated with the seven LOEs, together with each COC's percent contribution to cumulative ecological hazard.

As may be seen in Table 2, dioxin (represented as TCDD TEQ) drives ecological harm when averaged across each of the seven data LOEs. Averages for the nine COCs across all ecological LOEs result in the following associated percentage contributions to incremental ecological harm:

- Dioxin: 77.52%
- Total PCBs: 14.42%
- Total DDx: 3.45%
- Mercury: 2.23%
- Copper: 2.07%
- HPAHs: 0.15%
- Dieldrin: 0.09%
- LPAHs: 0.04%
- Lead: 0.03%

4.3 Cumulative Percent Contribution to Environmental Harm

Table 3 (Attachment A) presents the aggregated Percent Contributions to Environmental Harm by averaging two sets of values representative of human health LOEs (one for cancer and one for noncancer) from Section 4.1 with a third set of values representative of all ecological LOEs from Section 4.2. Consistent with the human health and ecological components discussed above, dioxin continues to exert the most significant influence on the overall estimates of Percent Contribution to Environmental Harm. The following percentages are presented within Table 3:

- Dioxin: 83.92%
- Total PCBs: 12.87%
- Total DDx: 1.37%
- Mercury: 0.95%
- Copper: 0.69%

- Dieldrin: 0.13%
- HPAHs: 0.05%
- LPAHs: 0.01%
- Lead: 0.01%

These Percent Contribution to Environmental Harm values are intended to establish the relative risk each OU2 COC poses to human health and the environment for purposes of the multi-faceted allocation.

Several factors are notable. First, copper, lead, and the PAHs confer no additional risk or hazard to the human health pathways based on screening and the consideration of background. Dieldrin confers low levels of risk and hazard to human health only via the ingestion of crab pathway, which uses tissue concentrations that were modeled from sediment even though site-related sediment concentrations are lower than newer background concentrations. Mercury confers only hazard, as it is presumed to have no carcinogenic potential.

5.0 SUMMARY

This document describes the approach taken to relatively rank nine COCs based on their Percent Contribution to Environmental Harm for purposes of the Allocation. This approach aggregates the human health and ecological risk LOEs results generated using environmental data collected in OU2. The primary sources of information that were used to derive Percent Contribution to Environmental Harm (via percent contribution to human health hazard or risk and percent contribution to ecological hazard) of each COC were the HHRA and ERA in Appendix D of the RI/FFS (Berger et al. 2014).

The percent contribution from human health model is based on risk and hazard point estimates associated with fish and crab tissue ingestion. Percent contribution to human health risk and percent contribution to human health hazard were both aggregated with percent contribution to ecological hazard results. The human health Percent Contributions to human health cancer risk and to human health hazard for each COC are provided in Table 1.

The percent contribution to ecological hazard model is based on HQs from seven RI/FFS ERA LOEs. These LOEs provide a complete assessment of ecological hazard to important components and organisms of a functioning tidal riverine ecosystem. Risk estimates from these seven LOEs were averaged before being aggregated with percent contribution to human health results. The percent Contribution to ecological hazard results for the nine COCs are provided in Table 2.

Table 3 provides the aggregated Percent Contribution to Environmental Harm results for each of the nine COCs. These ranked COCs, predicated on COC-specific contributions to total Environmental Harm, along with an Allocation Party's contribution of each COC in OU2

sediments and other relevant equitable factors, will be used to recommend a share of responsibility for each Allocation Party in the OU2 allocation.

6.0 REFERENCES

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ATTACHMENT A

TABLES 1 – 3

SUPPORTING TABLES
A1 – A13

Table 1 Human Health Hazard and Risk Results for Child and Adult Angler Exposed to Lower Passaic River Study Area Fish and Crab

COC	Human Health (OU2 Risks/Hazards)									
	Non-Cancer Hazard (Child)					Cancer Risk (Adult/Child)				
	Fish Diet Hazard	% Contribution	Crab Diet Hazard	% Contribution	Noncancer Hazard % Contribution[a]	Fish Diet Risk	% Contribution	Crab Diet Risk	% Contribution	Cancer Risk % Contribution[a]
Copper	--	0.00	--	0.00	0.00	--	0.00	--	0.00	0.00
Lead	--	0.00	--	0.00	0.00	--	0.00	--	0.00	0.00
Mercury	2.76	1.50	0.79	1.29	1.40	NC	0.00	NC	0.00	0.00
LPAHs	--	0.00	--	0.00	0.00	--	0.00	--	0.00	0.00
HPAHs	--	0.00	--	0.00	0.00	--	0.00	--	0.00	0.00
Dieldrin	0.38	0.21	0.08	0.13	0.17	7.57E-05	2.10	1.54E-05	1.10	1.60
DDx	2.10	1.14	0.43	0.71	0.93	1.18E-05	0.33	2.96E-06	0.21	0.27
Total PCBs	69.00	37.55	9.99	16.36	26.95	6.81E-04	18.89	9.84E-05	7.01	12.95
TCDD TEQ (D/F)	109.52	59.60	49.79	81.51	70.56	2.84E-03	78.69	1.29E-03	91.69	85.19
Totals =	**184**	**100**	**61**	**100**	**100**	**3.61E-03**	**100**	**1.40E-03**	**100**	**100**
COC	Human Health (Incremental Risks/Hazards)									
	Non-Cancer Hazard (Child)					Cancer Risk (Adult/Child)				
	Fish Diet Hazard	% Contribution	Crab Diet Hazard	% Contribution	Noncancer Hazard % Contribution[a]	Fish Diet Risk	% Contribution	Crab Diet Risk	% Contribution	Cancer Risk % Contribution[a]
Copper	--	0.00	--	0.00	0.00	--	0.00	--	0.00	0.00
Lead	--	0.00	--	0.00	0.00	--	0.00	--	0.00	0.00
Mercury	0.62	0.43	0.46	0.84	0.63	NC	0.00	NC	0.00	0.00
LPAHs	--	0.00	--	0.00	0.00	--	0.00	--	0.00	0.00
HPAHs	--	0.00	--	0.00	0.00	--	0.00	--	0.00	0.00
Dieldrin	Bkgd>LPRSA	0.00	0.04	0.06	0.03	Bkgd>LPRSA	0.00	6.96E-06	0.52	0.26
DDx	0.53	0.37	0.41	0.74	0.55	1.58E-06	0.05	2.10E-06	0.16	0.10
Total PCBs	35.18	24.40	5.11	9.19	16.79	3.47E-04	11.05	5.04E-05	3.75	7.40
TCDD TEQ (D/F)	107.85	74.80	49.61	89.17	81.99	2.80E-03	88.90	1.28E-03	95.57	92.24
Totals =	**144**	**100**	**56**	**100**	**100**	**3.14E-03**	**100**	**1.34E-03**	**100**	**100**

Footnotes:
a = Average of fish and crab diet risks/hazards
b = Average percent contributions for noncancer and cancer human LOEs

Acronyms:
COC = contaminant of concern
D/F = dioxin/furan congeners
DDx = DDx is sum of risks/hazards of DDD, DDE, and DDT.
FFS = focused feasibility study
HPAHs = high-molecular polycyclic aromatic hydrocarbons
LOE = line of evidence
LPAHs = low-molecular polycyclic aromatic hydrocarbons
LPRSA = lower Passaic River study area
NC = not calculated
PCB = polychlorinated biphenyls
TEQ = toxicity equivalent quotient

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Table 2 Hazard Results for Ecological Receptors Exposed to Lower Passaic River Study Area Fish, Crab, and Sediments

COC	Ecological (OU2 Hazards)							
	Tissue-Based LOEs				Sediment-Based LOE	Dietary-Based LOEs		Average % Contribution All Eco LOEs
	Forage fish (Mummichog)	Piscivorous Fish (Generic Fish)	Blue crab	Herring gull (Embryo)	Benthic Invertebrates	Mink Diet	Heron Diet	
Copper	1.69	0.21	3.11	0.00	0.48	1.69	8.32	2.21
Lead	0.00	0.00	0.22	0.00	0.67	0.44	11.34	1.81
Mercury	0.93	0.65	2.45	0.00	1.42	6.55	24.05	5.15
LPAHs	0.13	0.06	0.22	0.00	1.97	0.00	0.36	0.39
HPAHs	0.34	0.04	0.85	0.00	1.23	0.20	8.56	1.60
Dieldrin	0.78	0.67	1.42	0.03	1.36	0.71	0.34	0.76
DDx	0.60	0.58	0.85	3.52	1.03	0.05	19.11	3.68
Total PCBs	4.36	3.98	21.5	68.2	1.42	20.19	9.56	18.46
TCDD TEQ (D/F)	91.2	93.8	69.4	28.3	90.4	70.17	18.36	65.94
Totals =	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
COC	Ecological (Incremental Hazards)							
	Tissue-Based LOEs				Sediment-Based LOE	Dietary-Based LOEs		Average % Contribution All Eco LOEs
	Forage fish (Mummichog)	Piscivorous Fish (Generic Fish)	Blue crab	Herring gull (Embryo)	Benthic Invertebrates	Mink Diet	Heron Diet	
Copper	1.41	0.14	2.56	0.00	0.10	1.09	9.17	2.07
Lead	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.03
Mercury	0.00	0.08	1.57	0.00	0.45	1.50	12.03	2.23
LPAHs	0.05	0.01	0.22	0.00	0.00	0.00	0.00	0.04
HPAHs	0.22	0.01	0.81	0.00	0.00	0.00	0.00	0.15
Dieldrin	0.00	0.00	0.63	0.00	0.00	0.00	0.00	0.09
DDx	0.00	0.26	0.70	1.56	0.93	0.02	20.69	3.45
Total PCBs	0.00	2.57	10.7	57.16	1.27	14.76	14.44	14.42
TCDD TEQ (D/F)	98.3	96.9	82.6	41.28	97.2	82.63	43.66	77.52
Totals =	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Acronyms:
COC = contaminant of concern
D/F = dioxin/furan congeners
DDx = DDx is sum of risks/hazards of DDD, DDE, and DDT.
HPAHs = high-molecular polycyclic aromatic hydrocarbons
LOE = line of evidence
LPAHs = low-molecular polycyclic aromatic hydrocarbons
LPRSA = lower Passaic River study area
PCB = polychlorinated biphenyls
TEQ = toxicity equivalent quotient

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Table 3 Aggregated Lower Passaic River Study Area OU2 Percent Contributions to Overall Environmental Harm

COC	Non Incremental				Incremental			
	Noncancer Hazard % Contribution[a]	Cancer Risk % Contribution[b]	Average % Contribution All Eco LOEs[c]	% Contribution to Environmental Harm[d]	Noncancer Hazard % Contribution[a]	Cancer Risk % Contribution[b]	Average % Contribution All Eco LOEs[c]	% Contribution to Environmental Harm[d]
Copper	0.00	0.00	2.21	0.74	0.00	0.00	2.07	0.69
Lead	0.00	0.00	1.81	0.60	0.00	0.00	0.03	0.01
Mercury	1.40	0.00	5.15	2.18	0.63	0.00	2.23	0.95
LPAHs	0.00	0.00	0.39	0.13	0.00	0.00	0.04	0.01
HPAHs	0.00	0.00	1.60	0.53	0.00	0.00	0.15	0.05
Dieldrin	0.17	1.60	0.76	0.84	0.03	0.26	0.09	0.13
DDx	0.93	0.27	3.68	1.62	0.55	0.10	3.45	1.37
Total PCBs	26.95	12.95	18.46	19.45	16.79	7.40	14.42	12.87
TCDD TEQ (D/F)	70.56	85.19	65.94	73.89	81.99	92.24	77.52	83.92
Totals =	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Footnotes:
a = Percent contributions for noncancer LOE
b = Percent contributions for cancer LOE
c = Average percent contributions for all seven ecological LOEs
d = Cumulative average percent contributions for human noncancer hazard and cancer risk and ecological hazard LOEs

Acronyms:
COC = contaminant of concern
D/F = dioxin/furan congeners
DDx = DDx is sum of risks/hazards of DDD, DDE, and DDT.
HPAHs = high-molecular polycyclic aromatic hydrocarbons
LOE = line of evidence
LPAHs = low-molecular polycyclic aromatic hydrocarbons
PCB = polychlorinated biphenyls
TEQ = toxicity equivalent quotient

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Table A-1 Human Health Risk Assessment Exposure Point Concentrations and Toxicity Factors for Lower Passaic River Contaminants of Concern

Lower 8 Mile ROD COC	OU2 Fish EPC (mg/kg)[a]	OU2 Crab EPC (mg/kg)[b]	Background Fish EPC (mg/kg)[c]	Modeled Background Crab EPC (mg/kg)[d]	Oral RfD (mg/kg-day)[e]	CSF (1/mg/kg-day)[f]
4,4'-DDD	0.069	0.022	0.04957	incl w/ DDT	3.00E-05	0.24
4,4'-DDE	0.13	0.057	0.1145	incl w/ DDT	3.00E-04	0.34
4,4'-DDT	0.0046	0.0034	0.009239	0.022	5.00E-04	0.34
Dieldrin	0.025	0.0084	0.03274	0.0046	5.00E-05	16
Mercury[g]	0.36	0.17	0.2795	0.07	1.00E-04	NA
Total PCBs	1.8	0.43	0.882229	0.21	2.00E-05	2
TCDD TEQ (D/F)	0.0001	0.000075	0.000001527	0.00000027	7.00E-10	150000

Footnotes/data sources:

a = Table 3-2 Exposure Point Concentrations for the Human Health Risk Assessment in Louis Berger et al. (2014) Appendix D Risk Assessment; Lower 8 Mile Fish EPCs are 95% UCLs based on data from 39 fish fillet samples collected from the FFS Study Area for six species: American eel, common carp, smallmouth bass, white catfish, white perch, and white sucker. Note that Table 3-2 total PCBs represents the sum of nondioxin-like PCB congeners. Total PCBs value reported herein represent the sum of all 209 PCB congeners.

b = Table 3-2 Exposure Point Concentrations for the Human Health Risk Assessment in Louis Berger et al. (2014) Appendix D Risk Assessment; Lower 8 Crab EPCs are 95% UCLs based on data from 22 samples of blue crab (muscle and hepatopancreas tissue) collected from the FFS Study Area. Note that Table 3-2 total PCBs represent the sum of nondioxin-like PCB congeners. Total PCBs value reported herein represents the sum of all 209 PCB congeners.

c = Background Fish EPCs are 95% UCLs based on data from 47 background fish fillet samples collected from the Passaic River above Dundee Dam during the 17-Mile RI/FS for 8 species: brown bullhead, American eel, largemouth/smallmouth bass, common carp, channel catfish, white perch, white sucker, northern pike.

d = Table 3-3 Summary of Estimated Whole Body Tissue Concentrations(a) for Ecological COPECs Associated with Background Conditions in Louis Berger et al. (2014) Appendix E Development of PRGs

e = Attachment 4, Table 4-11 (RAGS Part D Table 5.1) Non-Cancer Toxicity Data - Oral/Dermal Lower Passaic River in Louis Berger et al. (2014) Appendix D Risk Assessment; Note that Table 4-12 did not provide RfDs for 4,4'-DDD or 4,4"DDE; These RfDs were obtained from the following USEPA reference documents:

4,4'-DDD, Provisional Peer-Reviewed Toxicity Values for p,p'-Dichlorodiphenyldichloroethane (p,p'-DDD), EPA/690/R-17/006, dated September 20, 2017.

4,4' -DDE, Provisional Peer-Reviewed Toxicity Values for p,p'-Dichlorodiphenyldichloroethylene (p,p'-DDE), EPA/690/R-17/007, dated September 26, 2017.

f = Attachment 4, Table 4-12 (RAGS Part D Table 6.1) Cancer Toxicity Data - Oral/Dermal Lower Passaic River in Louis Berger et al. (2014) Appendix D Risk Assessment

g = Oral reference dose for methylmercury

Acronyms:

COC = contaminant of concern
CSF = cancer slope factor
EPC = exposure point concentration
RfD = reference dose
ROD = Record of Decision
UCL = upper confidence limit
DDD = dichlorodiphenyldichloroethane
DDE = dichlorodiphenyldichloroethylene
DDT = dichlorodiphenyltrichloroethane
PCB = polychlorinated biphenyl
TEQ = toxicity equivalent quotient
NA = not available (mercury not carcinogenic)
RAGS = risk assessment guidance for superfund
D/F = dioxin/furan congeners
USEPA = United States Environmental Protection Agency
PRGs = preliminary remediation goals
COPEC = contaminant of potential ecological concern

References:

The Louis Berger Group. 2014 Focused Feasibility Study Report for the Lower Eight Miles of the Lower Passaic River. Produced in conjunction with Battelle, HDR, and HydroQual. Prepared for the U.S. Environmental Protection Agency, Region 2 and U.S. Army Corps of Engineers, Kansas City Division.

Table A-2 Human Health Risk Assessment Noncancer and Cancer Exposure Assumptions for Ingestion of Fish or Crab

Metric	Receptor	Fish			Crab		
		Assumed Value[a,b]	Units	Calculated Value	Assumed Value[c,d]	Units	Calculated Value
Ingestion Rate	Young Child	11.5	(g fish/day)	--	6.97	(g fish/day)	--
Ingestion Rate	Adult	34.6	(g fish/day)	--	20.9	(g fish/day)	--
Body Weight	Young Child	15	(kg)	--	15	(kg)	--
Body Weight	Adult	80	(kg)	--	80	(kg)	--
Exposure Frequency	Young Child	365	days/year	--	365	days/year	--
Exposure Frequency	Adult	365	days/ year	--	365	days/year	--
Exposure Duration (cancer)	Young Child	6	yr	--	6	yr	--
Exposure Duration (cancer)	Adult	20	yr	--	20	yr	--
Exposure Duration (noncancer)	Young Child	6	yr	--	6	yr	--
Exposure Duration (noncancer)	Adult	20	yr	--	20	yr	--
Averaging Time (Cancer)	Adult	--	days	2.56E+04	--	days	2.56E+04
Averaging Time (Non Cancer)	Adult	--	days	7.30E+03	--	days	7.30E+03
Averaging Time (Cancer)	Young Child	--	days	2.56E+04	--	days	2.56E+04
Averaging Time (Non Cancer)	Young Child	--	days	2.19E+03	--	days	2.19E+03
Conversion factor		0.001	kg/g		0.001	kg/g	
Intake Factors[e]		**Cancer**	**Noncancer**		**Cancer**	**Noncancer**	
Intake Factor Child [kg-fish]/[kg bw-day]		6.57E-05	7.67E-04		--	--	
Intake Factor_Adult [kg-fish]/[kg bw-day]		1.24E-04	4.33E-04		--	--	
Intake Factor Child [kg-crab]/[kg bw-day]		--	--		3.98E-05	4.65E-04	
Intake Factor_Adult [kg-crab]/[kg bw-day]		--	--		7.46E-05	2.61E-04	

Data sources:

a = Attachment 4, Table 4-5 (RAGS Part D Table 4.1) Values Used for Daily Intake Calculations Lower Passaic River in Louis Berger et al. (2014) Appendix D Risk Assessment; Child BW from the USEPA (2016) ROD, Section 7.1.2

b = Attachment 4, Table 4-7 (RAGS Part D Table 4.1) Values Used for Daily Intake Calculations Lower Passaic River in Louis Berger et al. (2014) Appendix D Risk Assessment

c = Attachment 4, Table 4-8 (RAGS Part D Table 4.1) Values Used for Daily Intake Calculations Lower Passaic River in Louis Berger et al. (2014) Appendix D Risk Assessment; Child BW from the USEPA (2016) ROD, Section 7.1.2

d = Attachment 4, Table 4-10 (RAGS Part D Table 4.1) Values Used for Daily Intake Calculations Lower Passaic River in Louis Berger et al. (2014) Appendix D Risk Assessment

e = Intake Factors calculated using the following equations:

Intake Factor Child [kg-crab]/[kg bw-day] = FIR x EF x ED x CF x 1/bw x 1/AT

Intake Factor Adult [kg-crab]/[kg bw-day] = FIR x EF x ED x CF x 1/bw x 1/AT

Notes:

The adult body weight (80kg) and adult cancer exposure duration (20 years) were updated from the original source to more recent/revised values obtained from USEPA (2014)

Acronyms:

AT = averaging time
bw = body weight
CF = conversion factor
ED = exposure duration
EF = exposure frequency
FIR = food ingestion rate
ROD = Record of Decision
USEPA = United States Environmental Protection Agency

References:

The Louis Berger Group. 2014 Focused Feasibility Study Report for the Lower Eight Miles of the Lower Passaic River. Produced in conjunction with Battelle, HDR, and HydroQual. Prepared for the U.S. Environmental Protection Agency, Region 2 and U.S. Army Corps of Engineers, Kansas City Division.

U.S. Environmental Protection Agency. 2014. Update of Standard Default Exposure Factors, OSWER Directive 9200.1-120, February 6.

U.S. Environmental Protection Agency. 2016. Record of Decision Lower 8.3 Miles of the Lower Passaic River Part of the Diamond Alkali Superfund Site Essex and Hudson Counties, New Jersey. March 3.

Table A-3 Calculations of Cancer Risks and Non-Cancer Hazards for a Child Angler (1 to <7 Years Old) Consuming Lower Passaic River Study Area and Background (Above Dundee Dam) Fish or Crab

Lower Passaic River Study Area OU2														
Medium	**Exposure Point**	**COC**	**EPC**		**Cancer Risk Calculations**					**Non-Cancer Hazard Calculations**				
			Value	Units	Intake/Exposure Concentration		CSF		Cancer Risk	Intake/Exposure Concentration		RfD		Hazard Quotient
					Value	Units	Value	Units		Value	Units	Value	Units	
Fish Ingestion	LPRSA Study Area	4,4'-DDD	6.90E-02	mg/kg	4.53E-06	mg/kg-day	2.40E-01	mg/kg-day $^{-1}$	1.E-06	5.E-05	mg/kg-day	3.00E-05	mg/kg-day	1.76E+00
		4,4'-DDE	1.30E-01	mg/kg	8.54E-06	mg/kg-day	3.40E-01	mg/kg-day $^{-1}$	3.E-06	1.E-04	mg/kg-day	3.00E-04	mg/kg-day	3.32E-01
		4,4'-DDT	4.60E-03	mg/kg	3.02E-07	mg/kg-day	3.40E-01	mg/kg-day $^{-1}$	1.E-07	4.E-06	mg/kg-day	5.00E-04	mg/kg-day	7.05E-03
		Dieldrin	2.50E-02	mg/kg	1.64E-06	mg/kg-day	1.60E+01	mg/kg-day $^{-1}$	3.E-05	2.E-05	mg/kg-day	5.00E-05	mg/kg-day	3.83E-01
		Mercury	3.60E-01	mg/kg	2.37E-05	mg/kg-day	NA	mg/kg-day $^{-1}$	NC	3.E-04	mg/kg-day	1.00E-04	mg/kg-day	2.76E+00
		Total PCBs	1.80E+00	mg/kg	1.18E-04	mg/kg-day	2.00E+00	mg/kg-day $^{-1}$	2.E-04	1.E-03	mg/kg-day	2.00E-05	mg/kg-day	6.90E+01
		TCDD TEQ (D/F)	1.00E-04	mg/kg	6.57E-09	mg/kg-day	1.50E+05	mg/kg-day $^{-1}$	1.E-03	8.E-08	mg/kg-day	7.00E-10	mg/kg-day	1.10E+02
Crab Ingestion	LPRSA Study Area	4,4'-DDD	2.E-02	mg/kg	9.E-07	mg/kg-day	2.40E-01	mg/kg-day $^{-1}$	2.10E-07	1.02E-05	mg/kg-day	3.00E-05	mg/kg-day	3.41E-01
		4,4'-DDE	6.E-02	mg/kg	2.E-06	mg/kg-day	3.40E-01	mg/kg-day $^{-1}$	7.72E-07	2.65E-05	mg/kg-day	3.00E-04	mg/kg-day	8.83E-02
		4,4'-DDT	3.E-03	mg/kg	1.E-07	mg/kg-day	3.40E-01	mg/kg-day $^{-1}$	4.60E-08	1.58E-06	mg/kg-day	5.00E-04	mg/kg-day	3.16E-03
		Dieldrin	8.E-03	mg/kg	3.E-07	mg/kg-day	1.60E+01	mg/kg-day $^{-1}$	5.35E-06	3.90E-06	mg/kg-day	5.00E-05	mg/kg-day	7.81E-02
		Mercury	2.E-01	mg/kg	7.E-06	mg/kg-day	NA	mg/kg-day $^{-1}$	NC	7.90E-05	mg/kg-day	1.00E-04	mg/kg-day	7.90E-01
		Total PCBs	4.E-01	mg/kg	2.E-05	mg/kg-day	2.00E+00	mg/kg-day $^{-1}$	3.43E-05	2.00E-04	mg/kg-day	2.00E-05	mg/kg-day	9.99E+00
		TCDD TEQ (D/F)	8.E-05	mg/kg	3.E-09	mg/kg-day	1.50E+05	mg/kg-day $^{-1}$	4.48E-04	3.49E-08	mg/kg-day	7.00E-10	mg/kg-day	4.98E+01
Background (Above Dundee Dam)														
Medium	**Exposure Point**	**COC**	**EPC**		**Cancer Risk Calculations**					**Non-Cancer Hazard Calculations**				
			Value	Units	Intake/Exposure Concentration		CSF		Cancer Risk	Intake/Exposure Concentration		RfD		Hazard Quotient
					Value	Units	Value	Units		Value	Units	Value	Units	
Fish Ingestion	Passaic River Above Dundee Dam (empirical)	4,4'-DDD	4.96E-02	mg/kg	3.26E-06	mg/kg-day	2.40E-01	mg/kg-day $^{-1}$	7.82E-07	3.80E-05	mg/kg-day	3.00E-05	mg/kg-day	1.27E+00
		4,4'-DDE	1.15E-01	mg/kg	7.52E-06	mg/kg-day	3.40E-01	mg/kg-day $^{-1}$	2.56E-06	8.78E-05	mg/kg-day	3.00E-04	mg/kg-day	2.93E-01
		4,4'-DDT	9.24E-03	mg/kg	6.07E-07	mg/kg-day	3.40E-01	mg/kg-day $^{-1}$	2.06E-07	7.08E-06	mg/kg-day	5.00E-04	mg/kg-day	1.42E-02
		Dieldrin	3.27E-02	mg/kg	2.15E-06	mg/kg-day	1.60E+01	mg/kg-day $^{-1}$	3.44E-05	2.51E-05	mg/kg-day	5.00E-05	mg/kg-day	5.02E-01
		Mercury	2.80E-01	mg/kg	1.84E-05	mg/kg-day	NA	mg/kg-day $^{-1}$	NC	2.14E-04	mg/kg-day	1.00E-04	mg/kg-day	2.14E+00
		Total PCBs	8.82E-01	mg/kg	5.80E-05	mg/kg-day	2.00E+00	mg/kg-day $^{-1}$	1.16E-04	6.76E-04	mg/kg-day	2.00E-05	mg/kg-day	3.38E+01
		TCDD TEQ (D/F)	1.53E-06	mg/kg	1.00E-10	mg/kg-day	1.50E+05	mg/kg-day $^{-1}$	1.51E-05	1.17E-09	mg/kg-day	7.00E-10	mg/kg-day	1.67E+00
Crab Ingestion	Passaic River Above Dundee Dam (modeled from sediment)	4,4'-DDD	incl w/ DDT	mg/kg	--	NA	2.40E-01	mg/kg-day $^{-1}$	NC	--	mg/kg-day	3.00E-05	mg/kg-day	NA
		4,4'-DDE	incl w/ DDT	mg/kg	--	NA	3.40E-01	mg/kg-day $^{-1}$	NC	--	mg/kg-day	3.00E-04	mg/kg-day	NA
		4,4'-DDT	2.20E-02	mg/kg	8.76E-07	mg/kg-day	3.40E-01	mg/kg-day $^{-1}$	2.98E-07	1.02E-05	mg/kg-day	5.00E-04	mg/kg-day	2.04E-02
		Dieldrin	4.60E-03	mg/kg	1.83E-07	mg/kg-day	1.60E+01	mg/kg-day $^{-1}$	2.93E-06	2.14E-06	mg/kg-day	5.00E-05	mg/kg-day	4.27E-02
		Mercury	7.00E-02	mg/kg	2.79E-06	mg/kg-day	NA	mg/kg-day $^{-1}$	NC	3.25E-05	mg/kg-day	1.00E-04	mg/kg-day	3.25E-01
		Total PCBs	2.10E-01	mg/kg	8.36E-06	mg/kg-day	2.00E+00	mg/kg-day $^{-1}$	1.67E-05	9.76E-05	mg/kg-day	2.00E-05	mg/kg-day	4.88E+00
		TCDD TEQ (D/F)	2.70E-07	mg/kg	1.08E-11	mg/kg-day	1.50E+05	mg/kg-day $^{-1}$	1.61E-06	1.25E-10	mg/kg-day	7.00E-10	mg/kg-day	1.79E-01

Intake Factor Child	Fish	Crab	Units
Cancer	6.57E-05	3.98E-05	[kg-crab]/[kg bw-day]
Noncancer	7.67E-04	4.65E-04	[kg-crab]/[kg bw-day]

Acronyms:
bw = body weight
COC = contaminant of concern
CSF = cancer slope factor
D/F = dioxin/furan congeners
EPC = exposure point concentration
LPRSA = lower Passaic River study area
NA = not available
NC = not calculated
PCB = polychlorinated biphenyls
RfD = reference dose
TEQ = toxicity equivalent quotient

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Table A-4 Calculations of Cancer Risks and Non-Cancer Hazards for an Adult Angler Consuming Lower Passaic River Study Area and Background (Above Dundee Dam) Fish or Crab

Lower Passaic River Study Area OU2

Medium	Exposure Point	COC	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
			Value	Units	Intake/Exposure Concentration		CSF		Cancer Risk	Intake/Exposure Concentration		RfD		Hazard Quotient
					Value	Units	Value	Units		Value	Units	Value	Units	
Fish Ingestion	LPRSA Study Area	4,4'-DDD	0.069	mg/kg	8.53E-06	mg/kg-day	2.40E-01	mg/kg-day^{-1}	2.E-06	2.98E-05	mg/kg-day	3.00E-05	mg/kg-day	0.995
		4,4'-DDE	0.130	mg/kg	1.61E-05	mg/kg-day	3.40E-01	mg/kg-day^{-1}	5.E-06	5.62E-05	mg/kg-day	3.00E-04	mg/kg-day	0.187
		4,4'-DDT	0.005	mg/kg	5.68E-07	mg/kg-day	3.40E-01	mg/kg-day^{-1}	2.E-07	1.99E-06	mg/kg-day	5.00E-04	mg/kg-day	0.004
		Dieldrin	0.025	mg/kg	3.09E-06	mg/kg-day	1.60E+01	mg/kg-day^{-1}	5.E-05	1.08E-05	mg/kg-day	5.00E-05	mg/kg-day	0.216
		Mercury	0.36	mg/kg	4.45E-05	mg/kg-day	NA	mg/kg-day^{-1}	NC	1.56E-04	mg/kg-day	1.00E-04	mg/kg-day	1.557
		Total PCBs	1.80	mg/kg	2.22E-04	mg/kg-day	2.00E+00	mg/kg-day^{-1}	4.E-04	7.79E-04	mg/kg-day	2.00E-05	mg/kg-day	38.925
		TCDD TEQ (D/F)	0.0001	mg/kg	1.2E-08	mg/kg-day	1.50E+05	mg/kg-day^{-1}	2.E-03	4.33E-08	mg/kg-day	7.00E-10	mg/kg-day	61.786
Crab Ingestion	LPRSA Study Area	4,4'-DDD	0.022	mg/kg	1.6E-06	mg/kg-day	2.40E-01	mg/kg-day^{-1}	4.E-07	5.75E-06	mg/kg-day	3.00E-05	mg/kg-day	0.192
		4,4'-DDE	0.057	mg/kg	4.3E-06	mg/kg-day	3.40E-01	mg/kg-day^{-1}	1.E-06	1.49E-05	mg/kg-day	3.00E-04	mg/kg-day	0.050
		4,4'-DDT	0.0034	mg/kg	2.5E-07	mg/kg-day	3.40E-01	mg/kg-day^{-1}	9.E-08	8.88E-07	mg/kg-day	5.00E-04	mg/kg-day	0.002
		Dieldrin	0.0084	mg/kg	6.3E-07	mg/kg-day	1.60E+01	mg/kg-day^{-1}	1.E-05	2.19E-06	mg/kg-day	5.00E-05	mg/kg-day	0.044
		Mercury	0.17	mg/kg	1.3E-05	mg/kg-day	NA	mg/kg-day^{-1}	NC	4.44E-05	mg/kg-day	1.00E-04	mg/kg-day	0.444
		Total PCBs	0.43	mg/kg	3.2E-05	mg/kg-day	2.00E+00	mg/kg-day^{-1}	6.E-05	1.12E-04	mg/kg-day	2.00E-05	mg/kg-day	5.617
		TCDD TEQ (D/F)	0.0001	mg/kg	5.6E-09	mg/kg-day	1.50E+05	mg/kg-day^{-1}	8.E-04	1.96E-08	mg/kg-day	7.00E-10	mg/kg-day	27.991

Background (Above Dundee Dam)

Medium	Exposure Point	COC	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
			Value	Units	Intake/Exposure		CSF		Cancer Risk	Intake/Exposure		RfD		Hazard Quotient
					Value	Units	Value	Units		Value	Units	Value	Units	
Fish Ingestion	Passaic River Above Dundee Dam (empirical)	4,4'-DDD	0.0496	mg/kg	6.13E-06	mg/kg-day	2.40E-01	mg/kg-day^{-1}	1.47E-06	2.14E-05	mg/kg-day	3.00E-05	mg/kg-day	0.71
		4,4'-DDE	0.1145	mg/kg	1.41E-05	mg/kg-day	3.40E-01	mg/kg-day^{-1}	4.81E-06	4.95E-05	mg/kg-day	3.00E-04	mg/kg-day	0.17
		4,4'-DDT	0.0092	mg/kg	1.14E-06	mg/kg-day	3.40E-01	mg/kg-day^{-1}	3.88E-07	4.00E-06	mg/kg-day	5.00E-04	mg/kg-day	0.01
		Dieldrin	0.0327	mg/kg	4.05E-06	mg/kg-day	1.60E+01	mg/kg-day^{-1}	6.47E-05	1.42E-05	mg/kg-day	5.00E-05	mg/kg-day	0.28
		Mercury	0.2795	mg/kg	3.45E-05	mg/kg-day	NA	mg/kg-day^{-1}	NC	1.21E-04	mg/kg-day	1.00E-04	mg/kg-day	1.21
		Total PCBs	0.8822	mg/kg	1.09E-04	mg/kg-day	2.00E+00	mg/kg-day^{-1}	2.18E-04	3.82E-04	mg/kg-day	2.00E-05	mg/kg-day	19.08
		TCDD TEQ (D/F)	0.00000153	mg/kg	1.89E-10	mg/kg-day	1.50E+05	mg/kg-day^{-1}	2.83E-05	6.60E-10	mg/kg-day	7.00E-10	mg/kg-day	0.94
Crab Ingestion	Passaic River Above Dundee Dam (modeled from sediment)	4,4'-DDD	incl w/ DDT	mg/kg	--	NA	2.40E-01	mg/kg-day^{-1}	NC	--	mg/kg-day	3.00E-05	mg/kg-day	NA
		4,4'-DDE	incl w/ DDT	mg/kg	--	NA	3.40E-01	mg/kg-day^{-1}	NC	--	mg/kg-day	3.00E-04	mg/kg-day	NA
		4,4'-DDT	2.20E-02	mg/kg	1.64E-06	mg/kg-day	3.40E-01	mg/kg-day^{-1}	5.6E-07	5.75E-06	mg/kg-day	5.00E-04	mg/kg-day	0.01
		Dieldrin	4.60E-03	mg/kg	3.43E-07	mg/kg-day	1.60E+01	mg/kg-day^{-1}	5.5E-06	1.20E-06	mg/kg-day	5.00E-05	mg/kg-day	0.02
		Mercury	7.00E-02	mg/kg	5.23E-06	mg/kg-day	NA	mg/kg-day^{-1}	NC	1.83E-05	mg/kg-day	1.00E-04	mg/kg-day	0.18
		Total PCBs	2.10E-01	mg/kg	1.57E-05	mg/kg-day	2.00E+00	mg/kg-day^{-1}	3.1E-05	5.49E-05	mg/kg-day	2.00E-05	mg/kg-day	2.74
		TCDD TEQ (D/F)	2.70E-07	mg/kg	2.02E-11	mg/kg-day	1.50E+05	mg/kg-day^{-1}	3.0E-06	7.05E-11	mg/kg-day	7.00E-10	mg/kg-day	0.10

Intake Factor Adult	Fish	Crab	Units
Cancer	1.24E-04	7.46E-05	[kg-crab]/[kg bw-day]
Noncancer	4.33E-04	2.61E-04	[kg-crab]/[kg bw-day]

Acronyms:

bw = body weight
COC = contaminant of concern
CSF = cancer slope factor
D/F = dioxin/furan congeners
EPC = exposure point concentration
LPRSA = lower Passaic River study area
NA = not available
NC = not calculated
PCB = polychlorinated biphenyls
RfD = reference dose
TEQ = toxicity equivalent quotient

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Table A-5 Calculation of Human Health Incremental Hazard and Risk Results for Child and Adult Angler Exposed to Lower Passaic River Study Area Fish and Crab

Lower Passaic River Study Area OU2								
COC	**Noncancer Hazard**		**Cancer**					
	Fish	Crab	Fish			Crab		
	Child	Child	Adult	Child	Adult/Child	Adult	Child	Adult/Child
4,4'-DDD	1.76	0.34	2.05E-06	1.09E-06	3.13E-06	3.94E-07	2.10E-07	6.04E-07
4,4'-DDE	0.33	0.09	5.46E-06	2.90E-06	8.37E-06	1.45E-06	7.72E-07	2.22E-06
4,4'-DDT	0.01	0.003	1.93E-07	1.03E-07	2.96E-07	8.63E-08	4.60E-08	1.32E-07
Dieldrin	0.38	0.08	4.94E-05	2.63E-05	7.57E-05	1.00E-05	5.35E-06	1.54E-05
Mercury	2.76	0.79	NC	NC	NC	NC	NC	NC
Total PCBs	69.00	9.99	4.45E-04	2.37E-04	6.81E-04	6.42E-05	3.43E-05	9.84E-05
TCDD TEQ (D/F)	109.52	49.8	1.85E-03	9.86E-04	2.84E-03	8.40E-04	4.48E-04	1.29E-03
Totals =	**183.8**	**61.1**	**2.36E-03**	**1.25E-03**	**3.61E-03**	**9.16E-04**	**4.89E-04**	**1.40E-03**
Background (Above Dundee Dam)								
COC	**Noncancer Hazard**		**Cancer**					
	Fish	Crab	Fish			Crab		
	Child	Child	Adult	Child	Adult/Child	Adult	Child	Adult/Child
4,4'-DDD	1.27	NA	1.47E-06	7.82E-07	2.25E-06	NC	NC	NC
4,4'-DDE	0.29	NA	4.81E-06	2.56E-06	7.37E-06	NC	NC	NC
4,4'-DDT	0.01	0.02	3.88E-07	2.06E-07	5.95E-07	5.58E-07	2.98E-07	8.56E-07
Dieldrin	0.50	0.04	6.47E-05	3.44E-05	9.92E-05	5.49E-06	2.93E-06	8.43E-06
Mercury	2.14	0.33	NC	NC	NC	NC	NC	NC
Total PCBs	33.82	4.88	2.18E-04	1.16E-04	3.34E-04	3.14E-05	1.67E-05	4.81E-05
TCDD TEQ (D/F)	1.67	0.18	2.83E-05	1.51E-05	4.34E-05	3.02E-06	1.61E-06	4.64E-06
Totals =	**39.7**	**5.45**	**3.18E-04**	**1.69E-04**	**4.87E-04**	**4.04E-05**	**2.16E-05**	**6.20E-05**
Incremental (LPRSA minus Background)[a]								
COC	**Noncancer Hazard**		**Cancer**					
	Fish	Crab	Fish			Crab		
	Child	Child	Adult	Child	Adult/Child	Adult	Child	Adult/Child
DDx[b]	0.53	0.41	1.03E-06	5.49E-07	1.58E-06	1.37E-06	7.30E-07	2.10E-06
Dieldrin	Bkgd>LPRSA	0.04	Bkgd>LPRSA			4.54E-06	2.42E-06	6.96E-06
Mercury	0.62	0.46	NC	NC	NC	NC	NC	NC
Total PCBs	35.18	5.11	2.27E-04	1.21E-04	3.47E-04	3.28E-05	1.75E-05	5.04E-05
TCDD TEQ (D/F)	107.85	49.61	1.83E-03	9.71E-04	2.80E-03	8.37E-04	4.46E-04	1.28E-03
Totals =	**144.2**	**55.6**	**2.05E-03**	**1.09E-03**	**3.14E-03**	**8.75E-04**	**4.67E-04**	**1.34E-03**

Footnotes:
a = Incremental risk/hazard calculated by subtracting background risk/hazard from LPRSA risk/hazard.
b = DDx is sum of risks/hazards of DDD, DDE, and DDT.

Acronyms:
COC = contaminant of concern
D/F = dioxin/furan congeners
LPRSA = lower Passaic River study area
NC = not calculated
PCB = polychlorinated biphenyls

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Table A-6 Benthic Invertebrate Ecological Risk Assessment Exposure Modeling, Risk Characterization, and Percent Contribution Calculations

COC	Units	Sediment Benchmarks		OU2 Sediment EPC			Background EPC		Incremental	
		Upper Bound (LOAEL)[a]	Source	EPC[b]	LOAEL HQ	% LOAEL Contribution	Empirical EPC[c]	LOAEL HQ	LOAEL HQ	% LOAEL Contribution
Copper	mg/kg	94.0	USEPA, 2005	170	1.81	0.48	136	1.45	0.36	0.10
Lead	mg/kg	94.0	USEPA, 2005	240	2.55	0.67	382	4.06	-1.51	0.00
Mercury	ug/kg	480	USEPA, 2005	2600	5.42	1.42	1833	3.82	1.60	0.45
Total LPAHs	ug/kg	3200	Long et al., 1995	24000	7.50	1.97	168521	52.7	-45.2	0.00
Total HPAHs	ug/kg	9600	Long et al., 1995	45000	4.69	1.23	217481	22.7	-18.0	0.00
Dieldrin	ug/kg	2.90	USEPA, 2005	15.0	5.17	1.36	17.1	5.88	-0.71	0.00
Total DDx	ug/kg	46.0	Long et al., 1995	180	3.91	1.03	28.8	0.63	3.29	0.93
Total PCB Congeners	ug/kg	370	USEPA, 2005	2000	5.41	1.42	337	0.91	4.49	1.27
2,3,7,8-TCDD	ng/kg	3.2	Kubiac et al., 2007[d]	1100	343.75	90.41	1.13	0.35	343.40	97.24
				HI =	380.2	100		HI =	353.1	100.00

Data Sources:

a = Table 4-12 Sediment Benchmark Values in Louis Berger et al. (2014) Appendix D Risk Assessment; except for 2,3,7,8-TCDD (see footnote d)

b = Table 4-1 Exposure Point Concentrations (EPCs) Used in the BERA in Louis Berger et al. (2014) Appendix D Risk Assessment. Note that OU2 DDx value represents the revised sediment dataset with the Terra removal area sample removed. See report text for more details

c = Background EPCs based on empirical data (includes all surface sediment data above Dundee Dam (AECOM 2014). Values are 95UCL EPCs calculated using ProUCL.

d = 2,3,7,8-TCDD sediment benchmark is a lower bound value; Louis Berger et al. (2004) did not report an upper bound sediment benchmark for 2,3,7,8-TCDD

Notes:

Negative values for Incremental HQs mean that background > LPRSA

Acronyms:

BERA = baseline ecological risk assessment
COC = contaminant of concern
DDx = sum of DDD, DDE, and DDT.
EPC = exposure point concentration
HI = hazard index
HPAHs = high-molecular polycyclic aromatic hydrocarbons
HQ = hazard quotient
LOAEL = lowest observed adverse effect level
LPAHs = low-molecular polycyclic aromatic hydrocarbons
NOAEL = no observed adverse effect level
PCB = polychlorinated biphenyl
UCL = upper confidence limit

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Table A-7 Fish and Crab Tissue-Based Ecological Risk Assessment Exposure Modeling, Risk Characterization, and Percent Contribution Calculations

COC	Units	CBRs		OU2 Fish and Crab Tissues			Background Fish and Crab Tissues		Incremental	
		LOAEL[a]	Source	EPC[b]	LOAEL HQ	% contribution LOAEL HQ to HI	Empirical EPC[c]	LOAEL HQ	LOAEL HQ	% contribution LOAEL HQ to HI
Forage fish (Mummichog)										
Copper[d]	mg/kg	See fish dietary exposure risk tables		--	0.45	1.69	--	0.12	0.33	1.41
Lead[d]	mg/kg	See fish dietary exposure risk tables		--	0.00	0.00	--	0.00	0.00	0.00
Mercury	ug/kg	260	Beckvar et al., 2005	65.0	0.25	0.93	125	0.48	-0.23	0.00
Total LPAHs	ug/kg	2600	Hall and Oris, 1991	93.0	0.036	0.13	60.1	0.02	0.01	0.05
Total HPAHs	ug/kg	2100	Hose et al., 1982	190	0.090	0.34	82.4	0.04	0.05	0.22
Dieldrin	ug/kg	40	Shubat and Curtis, 1986	8.40	0.21	0.78	22.0	0.55	-0.34	0.00
Total DDx	ug/kg	390	Beckvar et al., 2005	63.0	0.16	0.60	120	0.31	-0.15	0.00
Total PCBs	ug/kg	530	Lerner et al., 2007	620	1.17	4.36	853	1.61	-0.44	0.00
TCDD TEQ-Fish	ng/kg	1.8	Couillard et al., 2011	44.0	24.4	91.2	2.50	1.39	23.1	98.3
				HI =	**26.8**	**100**		**HI =**	**23.5**	**100.0**
Piscivorous Fish (Generic Fish)										
Copper[d]	mg/kg	See fish dietary exposure risk tables		--	0.30	0.21	--	0.11	0.19	0.14
Lead[d]	mg/kg	See fish dietary exposure risk tables		--	0.00	0.00	--	0.00	0.00	0.00
Mercury	ug/kg	260	Beckvar et al., 2005	240	0.92	0.65	213	0.82	0.10	0.08
Total LPAHs	ug/kg	2600	Hall and Oris, 1991	230	0.09	0.06	185	0.07	0.02	0.01
Total HPAHs	ug/kg	2100	Hose et al., 1982	130	0.06	0.04	101	0.05	0.01	0.01
Dieldrin	ug/kg	40	Shubat and Curtis, 1986	38.0	0.95	0.67	39.7	0.99	-0.04	0.00
Total DDx	ug/kg	390	Beckvar et al., 2005	320	0.82	0.58	185	0.47	0.35	0.26
Total PCBs	ug/kg	530	Lerner et al., 2007	3000	5.66	3.98	1153	2.18	3.48	2.57
TCDD TEQ-Fish	ng/kg	1.8	Couillard et al., 2011	240	133	93.8	3.24	1.80	132	96.94
				HI =	**142**	**100**		**HI =**	**136**	**100**
Blue crab										
Copper	mg/kg	12	Absil et al., 1996	24.0	2.00	3.1	7.50	0.63	1.38	2.56
Lead	mg/kg	2.6	Borgmann and Norwood, 1999	0.37	0.14	0.2	0.12	0.05	0.10	0.18
Mercury	ug/kg	95	Hook and Fisher, 2002	150	1.58	2.5	70.0	0.74	0.84	1.57
Total LPAHs	ug/kg	780	Emery and Dillon, 1996	110	0.14	0.2	17.0	0.02	0.12	0.22
Total HPAHs	ug/kg	220	Eertman et al., 1995	120	0.55	0.8	24.0	0.11	0.44	0.81
Dieldrin	ug/kg	8.0	Parrish et al., 1973	7.3	0.91	1.4	4.60	0.58	0.34	0.63
Total DDx	ug/kg	130	Nimmo et al., 1970	71.0	0.55	0.8	22.0	0.17	0.38	0.70
Total PCBs	ug/kg	26	Chu et al., 2000; 2003	360	13.8	21.5	210	8.08	5.77	10.73
2,3,7,8-TCDD	ng/kg	1.3	Wintermyer and Cooper, 2003	58.0	44.6	69.4	0.27	0.21	44.4	82.60
				HI =	**64.3**	**100**		**HI =**	**53.8**	**100**

Data Sources:

a = Table 4-13 Summary of Critical Body Residue Threshold Values for Various Ecological Receptors in Louis Berger et al. (2014) Appendix D Risk Assessment

b = Table 7-6: Exposure Point Concentrations for Baseline Conditions for the BERA in Louis Berger et al. (2014) Lower Passaic River Remedial Investigation Report

c = Fish tissue background values are based on empirical data for fish above Dundee Dam; values are 95UCL or maximum (when 95UCLs could not be calculated) EPCs calculated using ProUCL. Crab values are from Table 3-3 Summary of Estimated Whole Body Tissue Concentrations(a) for Ecological COPECs Associated with Background Conditions Louis Berger et al. (2014) Appendix E Development of PRGs.

d = Copper and lead risks evaluated using dietary modeling; see Tables A-11, A-12, and A-13 for HQ derivation information

Notes:

Background EPCs based on empirical data for fish; background EPCs are based on modeled background data from FFS (no empirical crab data above Dundee Dam)

Background EPCs for small forage fish are maximum values from n=3 samples (banded killifish, pumpkinseed, and silver shiner)

Background EPC calculated EPCs using ProUCL for data for generic fish (American eel, brown bullhead, carp, channel catfish, northern pike, smallmouth bass, white perch, and white sucker)

All concentrations are based on wet weight

LPRSA mummichog and generic fish tissues dioxin TEQ-fish values are based on 2,3,7,8-TCDD; Inspection of co-reported mammal TCDD TEQ data (Table 7-9 in the RI) indicate that incorporation of additional isomers would little effect on total fish-based dioxin TEQ

Negative values for Incremental HQs mean that background > LPRSA

Acronyms:

CBR = critical body residue
COC = contaminant of concern
COPEC = contaminant of potential ecological concern
DDx = sum of DDD, DDE, and DDT.
EPC = exposure point concentration
FFS = focused feasibility study
HI = hazard index
HPAHs = high-molecular polycyclic aromatic hydrocarbons
HQ = hazard quotient
LOAEL = lowest observed adverse effect level
LPAHs = low-molecular polycyclic aromatic hydrocarbons
PRG = preliminary remediation goal
PCB = polychlorinated biphenyl
RI = remedial investigation
RM = river mile
TEQ = toxic equivalent
UCL = upper confidence limit

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Table A-8 Mink Ecological Risk Assessment Exposure Modeling, Risk Characterization, and Percent Contribution Calculations

Lower Passaic River Study Area OU2

COC	Generic fish		Blue crab		Sediment		Dose		Dietary TRVs			LOAEL HQ	% Contribution of LOAEL HQ to HI
	$C_{prey1,\ ww}$ [a]	Units	$C_{prey2,\ ww}$ [a]	Units	$C_{sed,dw}$ [a]	Units	C_{dose} [b]	Units	Mammal diet LOAEL[c]	Units	TRV source		
Copper	12	mg/kg	24.0	mg/kg	170	mg/kg	4.93	mg/kg bw/day	6.80	mg/kg bw/day	Aulerich et al., 1982	0.73	1.69
Lead	0.5	mg/kg	0.37	mg/kg	240	mg/kg	1.33	mg/kg bw/day	7.00	mg/kg bw/day	Grant et al., 1980	0.19	0.44
Mercury	240	ug/kg	150	ug/kg	2600	ug/kg	75.9	µg/kg bw/day	27.0	µg/kg bw/day	Wobeser et al., 1976a,b as derived in USEPA, 1995	2.81	6.55
Total LPAHs	230	ug/kg	110	ug/kg	24000	ug/kg	178	µg/kg bw/day	150000	µg/kg bw/day	Navarro et al., 1991a,b	0.0012	0.00
Total HPAHs	130	ug/kg	120	ug/kg	45000	ug/kg	261	µg/kg bw/day	3100	µg/kg bw/day	Culp et al., 2000	0.084	0.20
Dieldrin	38	ug/kg	7.30	ug/kg	15.0	ug/kg	9.10	µg/kg bw/day	30.0	µg/kg bw/day	Harr et al., 1970	0.30	0.71
Total DDx	320	ug/kg	71.0	ug/kg	180	ug/kg	77.5	µg/kg bw/day	4000	µg/kg bw/day	Fitzhugh, 1948	0.019	0.05
Total PCB Congeners	3000	ug/kg	360	ug/kg	2000	ug/kg	710	µg/kg bw/day	82.0	µg/kg bw/day	Chapman, 2003	8.66	20.19
Dioxin TEQ-Mammal	250	ng/kg	63.0	ng/kg	1200	ng/kg	66.2	ng/kg bw/day	2.20	ng/kg bw/day	Tillitt et al., 1996	30.1	70.17
											HI =	**42.91**	**100.0**

Background (Above Dundee Dam)

COC	Generic fish		Blue crab		Sediment		Dose		Dietary TRVs			LOAEL HQ	% Contribution of LOAEL HQ to HI
	$C_{prey1,\ ww}$ [d]	Units	$C_{prey2,\ ww}$ [e]	Units	$C_{sed,dw}$ [f]	Units	C_{dose} [b]	Units	Mammal diet LOAEL[c]	Units	TRV source		
Copper	5.10	mg/kg	7.50	mg/kg	136	mg/kg	2.26	mg/kg bw/day	6.80	mg/kg bw/day	Aulerich et al., 1982	0.33	4.55
Lead	0.61	mg/kg	0.12	mg/kg	382	mg/kg	2.05	mg/kg bw/day	7.00	mg/kg bw/day	Grant et al., 1980	0.29	4.02
Mercury	213	ug/kg	70.0	ug/kg	1833	ug/kg	61.4	µg/kg bw/day	27.0	µg/kg bw/day	Wobeser et al., 1976a,b as derived in USEPA, 1995	2.27	31.11
Total LPAHs	185	ug/kg	17.0	ug/kg	168521	ug/kg	885	µg/kg bw/day	150000	µg/kg bw/day	Navarro et al., 1991a,b	0.01	0.08
Total HPAHs	101	ug/kg	24.0	ug/kg	217481	ug/kg	1112	µg/kg bw/day	3100	µg/kg bw/day	Culp et al., 2000	0.36	4.91
Dieldrin	39.7	ug/kg	4.60	ug/kg	17.1	ug/kg	9.35	µg/kg bw/day	30.0	µg/kg bw/day	Harr et al., 1970	0.31	4.27
Total DDx	185	ug/kg	22.0	ug/kg	28.8	ug/kg	43.3	µg/kg bw/day	4000	µg/kg bw/day	Fitzhugh, 1948	0.01	0.15
Total PCB Congeners	1153	ug/kg	210	ug/kg	337	ug/kg	275	µg/kg bw/day	82.0	µg/kg bw/day	Chapman, 2003	3.35	45.89
Dioxin TEQ-Mammal	3.06	ng/kg	0.27	ng/kg	20.2	ng/kg	0.81	ng/kg bw/day	2.20	ng/kg bw/day	Tillitt et al., 1996	0.37	5.03
											HI =	**7.31**	**100.0**

Incremental (Background Adjusted)

COC	Incremental (Using Modeled Crab)	
	LOAEL HQ	**% Contribution LOAEL HQ to HI**
Copper	0.39	1.09
Lead	-0.1	0.00
Mercury	0.54	1.50
Total LPAHs	-0.005	0.00
Total HPAHs	-0.3	0.00
Dieldrin	-0.01	0.00
Total DDx	0.0085	0.024
Total PCBs	5.3	14.8
Dioxin TEQ-Mammal	29.74	82.6
HI =	**36**	**2.6**

Data Sources:

a = Table 4-1 Exposure Point Concentrations (EPCs) Used in the BERA in Louis Berger et al. (2014) Appendix D Risk Assessment. Note that OU2 DDx value represents the revised sediment dataset with the Terra removal area sample removed. See report text for more details.

b = Dietary dose (mg/kg bw/d) = (([Csw*WIR] + [Cprey*FIR] + [Csed*SIR])/bw) *SUF

FIR	0.17	kg ww/day
SIR	0.003	kg dw/day
BW	0.6	kg
SUF	1	unitless

c = Table 4-14 Summary of Toxicity Reference Values for Avian and Mammalian Wildlife Receptors in Louis Berger et al. (2014) Appendix D Risk Assessment

d = Background EPCs based on empirical data for fish above Dundee Dam. Values are 95UCL EPCs calculated using ProUCL. Background generic fish include American eel, brown bullhead, carp, channel catfish, northern pike, smallmouth bass, white perch, and white sucker

e = Table 3-3 Summary of Estimated Whole Body Tissue Concentrations(a) for Ecological COPECs Associated with Background Conditions in Louis Berger et al. (2014) Appendix E Development of PRGs; Note that the dioxin TEQ value is for 2,3,7,8-TCDD only

f = Values represent 95%UCL background surface sediment data from AECOM (2014) derived using ProUCL 5.1 software

Notes:

Diet is 80% fish and 20% crab in FFS (Louis Berger et al., 2014)
Negative values for Incremental HQs mean that background > LPRSA

Acronyms:

BERA = baseline ecological risk assessment
bw = body weight
COC = contaminant of concern
DDx = sum of DDD, DDE, and DDT.
dw =dry weight
EPC = exposure point concentration
FFS = Focused Feasibility Study
FIR = food ingestion rate
HI = hazard index
HPAHs = high-molecular polycyclic aromatic hydrocarbons
HQ = hazard quotient
LOAEL = lowest observed adverse effect level
LPAHs = low-molecular polycyclic aromatic hydrocarbons
PCB = polychlorinated biphenyl
SIR = sediment ingestion rate
SUF = site use factor
TEQ = toxic equivalent
TRV = toxicity reference value
UCL = upper confidence limit
WIR = water ingestion rate
ww = wet weight

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Table A-9 Heron Ecological Risk Assessment Exposure Modeling, Risk Characterization, and Percent Contribution Calculations

Lower Passaic River Study Area OU2

COC	Generic fish		Blue crab		Sediment		Dose		Dietary TRVs			LOAEL HQ	% Contribution of LOAEL HQ to HI
	$C_{prey1, ww}$ [a]	Units	$C_{prey2, ww}$ [a]	Units	$C_{sed,dw}$ [a]	Units	C_{dose} [b]	Units	Heron Resident Piscivorous Fish (Generic fish) Diet LOAEL[c]	Units	TRV source		
Copper	12.0	mg/kg	24.0	mg/kg	170	mg/kg	3.91	mg/kg bw/day	4.70	mg/kg bw/day	Kashani et al., 1986	0.83	8.32
Lead	0.50	mg/kg	0.37	mg/kg	240	mg/kg	2.16	mg/kg bw/day	1.90	mg/kg bw/day	Edens and Garlich, 1983	1.14	11.34
Mercury	240	ug/kg	150	ug/kg	2600	ug/kg	62.6	μg/kg bw/day	26.0	μg/kg bw/day	Heinz, 1974, 1976, 1979	2.41	24.05
Total LPAHs	230	ug/kg	110	ug/kg	24000	ug/kg	245	μg/kg bw/day	6700	μg/kg bw/day	Schafer et al., 1983	0.04	0.36
Total HPAHs	130	ug/kg	120	ug/kg	45000	ug/kg	411	μg/kg bw/day	480	μg/kg bw/day	Hough et al., 1993	0.86	8.56
Dieldrin	38.0	ug/kg	7.30	ug/kg	15	ug/kg	6.05	μg/kg bw/day	180	μg/kg bw/day	Wiese et al., 1969	0.03	0.34
Total DDx	320	ug/kg	71.0	ug/kg	180	ug/kg	51.7	μg/kg bw/day	27.0	μg/kg bw/day	Anderson et al., 1975	1.91	19.11
Total PCBs	3000	ug/kg	360	ug/kg	2000	ug/kg	479	μg/kg bw/day	500	μg/kg bw/day	Chapman, 2003	0.96	9.56
Dioxin TEQ-Bird	260	ng/kg	73.0	ng/kg	1200	ng/kg	51.5	ng/kg bw/day	28.0	ng/kg bw/day	Nosek et al., 1992a, 1992b	1.84	18.36
											HI =	**10.01**	**100.0**

Background (Above Dundee Dam)

COC	Generic fish		Blue crab		Sediment		Dose		Dietary TRVs			LOAEL HQ	% Contribution of LOAEL HQ to HI
	$C_{prey1, ww}$ [d]	Units	$C_{prey2, ww}$ [e]	Units	$C_{sed,dw}$ [f]	Units	C_{dose} [b]	Units	Heron Resident Piscivorous Fish (Generic fish) Diet LOAEL[c]	Units	TRV source		
Copper	5.10	mg/kg	7.50	mg/kg	136	mg/kg	2.14	mg/kg bw/day	4.70	mg/kg bw/day	Kashani et al., 1986	0.46	4.64
Lead	0.61	mg/kg	0.12	mg/kg	382	mg/kg	3.39	mg/kg bw/day	1.90	mg/kg bw/day	Edens and Garlich, 1983	1.79	18.17
Mercury	213	ug/kg	70.0	ug/kg	1833	ug/kg	49.8	μg/kg bw/day	26.0	μg/kg bw/day	Heinz, 1974, 1976, 1979	1.91	19.46
Total LPAHs	185	ug/kg	17.0	ug/kg	168521	ug/kg	1484	μg/kg bw/day	6700	μg/kg bw/day	Schafer et al., 1983	0.22	2.25
Total HPAHs	101	ug/kg	24.0	ug/kg	217481	ug/kg	1894	μg/kg bw/day	480	μg/kg bw/day	Hough et al., 1993	3.95	40.13
Dieldrin	39.7	ug/kg	4.60	ug/kg	17.1	ug/kg	6.25	μg/kg bw/day	180	μg/kg bw/day	Wiese et al., 1969	0.03	0.35
Total DDx	185	ug/kg	22.0	ug/kg	28.8	ug/kg	28.7	μg/kg bw/day	27.0	μg/kg bw/day	Anderson et al., 1975	1.06	10.82
Total PCBs	1153	ug/kg	210	ug/kg	337	ug/kg	182	μg/kg bw/day	500	μg/kg bw/day	Chapman, 2003	0.36	3.71
Dioxin TEQ-Bird	6.21	ng/kg	0.27	ng/kg	37.6	ng/kg	1.27	ng/kg bw/day	28.0	ng/kg bw/day	Nosek et al., 1992a, 1992b	0.05	0.46
											HI =	**9.83**	**100.0**

Incremental (Background adjusted)

COC	Incremental (Using Modeled Crab)	
	LOAEL HQ	**% Contribution LOAEL HQ to HI**
Copper	0.38	9.17
Lead	-0.65	0.00
Mercury	0.49	12.0
Total LPAHs	-0.18	0.00
Total HPAHs	-3.09	0.00
Dieldrin	-0.001	0.00
Total DDx	0.85	20.69
Total PCBs	0.59	14.44
Dioxin TEQ-Bird	1.79	43.66
HI =	**4.11**	**100**

Data Sources:

a = Table 4-1 Exposure Point Concentrations (EPCs) Used in the BERA in Louis Berger et al. (2014) Appendix D Risk Assessment. Note that OU2 DDx value represents the revised sediment dataset with the Terra removal area sample removed. See report text for more details.

b = Dietary dose (mg/kg bw/d) = (([Csw*WIR] + [Cprey*FIR] + [Csed*SIR])/BW) *SUF

FIR	0.39	kg ww/day
SIR	0.019	kg dw/day
BW	2.2	kg
SUF	1	unitless

c = Table 4-14 Summary of Toxicity Reference Values for Avian and Mammalian Wildlife Receptors in Louis Berger et al. (2014) Appendix D Risk Assessment

d = Background EPCs based on empirical data for fish above Dundee Dam. Values are 95UCL EPCs calculated using ProUCL. Background generic fish include American eel, brown bullhead, carp, channel catfish, northern pike, smallmouth bass, white perch, and white sucker

e = Table 3-3 Summary of Estimated Whole Body Tissue Concentrations(a) for Ecological COPECs Associated with Background Conditions in Louis Berger et al. (2014) Appendix E Development of PRGs

f = Values represent 95%UCL background surface sediment data from AECOM (2014) derived using ProUCL 5.1 software

Notes:

Diet is 85% fish and 15% crab in FFS (Louis Berger et al., 2014)

Modeled background blue crab EPCs as presented in Table 9-226 in Appendix D of the FFS (Louis Berger et al. 2014); note no dioxin TEQ value (value is 2,3,7,8-TCDD)

Negative values for Incremental HQs mean that background > LPRSA

Acronyms:

BERA = baseline ecological risk assessment
bw = body weight
COC = contaminant of concern
DDx = sum of DDD, DDE, and DDT.
dw =dry weight
EPC = exposure point concentration
FFS = Focused Feasibility Study
FIR = food ingestion rate
HI = hazard index
HPAHs = high-molecular polycyclic aromatic hydrocarbons
HQ = hazard quotient
LOAEL = lowest observed adverse effect level
LPAHs = low-molecular polycyclic aromatic hydrocarbons
PCB = polychlorinated biphenyl
SIR = sediment ingestion rate
SUF = site use factor
TEQ = toxic equivalent
TRV = toxicity reference value
UCL = upper confidence limit
WIR = water ingestion rate
ww = wet weight

References:

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Table A-9 Herring Gull Embryo Ecological Risk Assessment Exposure Modeling, Risk Characterization, and Percent Contribution Calculations

COC	Lower Passaic River Study Area OU2										
	Prey		Dose					TRV			
	C_{prey} (Generic fish)[a]	C_{prey} (units)	BMF[b]	Diet Concentration (µg/g ww)	Dioxin TEF (avian)[c]	Lipid (g/g)[d]	C_{egg} (ug/g ww)	Bird egg LOAEL[e]	TRV units	LOAEL HQ	% Contribution of LOAEL HQ to HI
Dioxin/Furans											
2,3,7,8-TCDD	2.40E-04	ug/g ww	7.0	0.001680	1	1.305	0.002193	0.00015	ug/g ww		
1,2,3,7,8-PeCDD	2.70E-06	ug/g ww	3.3	0.000009	1	1.305	0.000012	0.00015	ug/g ww		
2,3,4,7,8-PeCDF	1.30E-05	ug/g ww	1.6	0.000021	1	1.305	0.000027	0.00015	ug/g ww		
1,2,3,6,7,8-HxCDD	5.10E-06	ug/g ww	6.0	0.000031	0.01	1.305	0.000000	0.00015	ug/g ww		
Total Dioxin/Furan TEQ							0.002232	0.00015	ug/g ww	14.88	28.29
Coplanar PCBs (not used, see total PCBs):											
PCB-77	2.90E-03	ug/g ww	6.0	0.017400	0.05	1.305	0.001135	0.00015	ug/g ww		
PCB-81	1.90E-04	ug/g ww	6.0	0.001140	0.1	1.305	0.000149	0.00015	ug/g ww		
PCB-126	2.70E-04	ug/g ww	8.0	0.002160	0.1	1.305	0.000282	0.00015	ug/g ww		
PCB-118	1.30E-01	ug/g ww	11.2	1.456000	0.00001	1.305	0.000019	0.00015	ug/g ww		
PCB-114	3.40E-03	ug/g ww	8.0	0.027200	0.0001	1.305	0.000004	0.00015	ug/g ww		
PCB-123	2.60E-03	ug/g ww	8.0	0.020800	0.00001	1.305	0.000000	0.00015	ug/g ww		
PCB-167	9.00E-03	ug/g ww	13.3	0.119700	0.00001	1.305	0.000002	0.00015	ug/g ww		
PCB-105	4.90E-02	ug/g ww	6.1	0.298900	0.0001	1.305	0.000039	0.00015	ug/g ww		
PCB-156	2.20E-02	ug/g ww	13.3	0.292600	0.0001	1.305	0.000038	0.00015	ug/g ww		
PCB-189	2.70E-03	ug/g ww	12.8	0.034560	0.00001	1.305	0.000000	0.00015	ug/g ww		
PCB TEQ							0.001668	0.00015	ug/g ww	11.12	Not used
Total PCBs	3.00	ug/g ww	11.9	35.70		1.305	46.59	1.3	ug/g ww	35.84	68.15
Dieldrin	0.04	ug/g ww	2.8	0.11		1.305	0.14	8.1	ug/g ww	0.02	0.03
Total DDx	0.32	ug/g ww	13.3	4.26		1.305	5.55	3.0	ug/g ww	1.85	3.52
									HI =	**52.59**	**100.0**

COC	Background (Above Dundee Dam)										
	Prey		Dose					TRV			
	C_{prey} (Generic fish)[f]	C_{prey} (units)	BMF[b]	Diet Concentration (µg/g ww)	Dioxin TEF (avian)[c]	Lipid (g/g)[g]	C_{egg} (ug/g ww)	Bird egg LOAEL[e]	TRV units	LOAEL HQ	% Contribution of LOAEL HQ to HI
Dioxin/Furans											
2,3,7,8-TCDD	1.188	ng/kg ww	7	0.000083	1	1.640	0.000136	0.00015	ug/g ww		
1,2,3,7,8-PeCDD	0.951	ng/kg ww	3.3	0.000031	1	1.640	0.000051	0.00015	ug/g ww		
2,3,4,7,8-PeCDF	1.329	ng/kg ww	1.6	0.000021	1	1.640	0.000035	0.00015	ug/g ww		
1,2,3,6,7,8-HxCDD	1.685	ng/kg ww	6	0.000101	0.01	1.640	0.000002	0.00015	ug/g ww		
Total Dioxin/Furan TEQ							0.000224	0.00015	ug/g ww	1.50	7.42
Coplanar PCBs (Not used, see total PCBs):											
PCB-77	1.171	µg/kg ww	6.0	0.007026	0.05	1.640	0.000576	0.00015	ug/g ww		
PCB-81	0.0673	µg/kg ww	6.0	0.000404	0.1	1.640	0.000066	0.00015	ug/g ww		
PCB-126	0.191	µg/kg ww	8.0	0.001528	0.1	1.640	0.000251	0.00015	ug/g ww		
PCB-118	62.49	µg/kg ww	11.2	0.699888	0.00001	1.640	0.000011	0.00015	ug/g ww		
PCB-114	1.492	µg/kg ww	8.0	0.011936	0.0001	1.640	0.000002	0.00015	ug/g ww		
PCB-123	1.281	µg/kg ww	8.0	0.010248	0.00001	1.640	0.000000	0.00015	ug/g ww		
PCB-167	4.144	µg/kg ww	13.3	0.055115	0.00001	1.640	0.000001	0.00015	ug/g ww		
PCB-105	23.38	µg/kg ww	6.1	0.142618	0.0001	1.640	0.000023	0.00015	ug/g ww		
PCB-156	9.903	µg/kg ww	13.3	0.131710	0.0001	1.640	0.000022	0.00015	ug/g ww		
PCB-189	0.794	µg/kg ww	12.8	0.010163	0.00001	1.640	0.000000	0.00015	ug/g ww		
PCB TEQ							0.000953	0.00015	ug/g ww	6.35	Not used
Total PCBs	1153	µg/kg ww	11.9	13.72		1.640	22.50	1.3	ug/g ww	17.31	85.81
Dieldrin	39.72	µg/kg ww	2.8	0.11		1.640	0.18	8.1	ug/g ww	0.02	0.11
Total DDx	185	µg/kg ww	13.3	2.46		1.640	4.04	3.0	ug/g ww	1.35	6.67
									HI =	**20.17**	**100.0**

Incremental (Background adjusted)

COC	Incremental	
	LOAEL HQ	**% Contribution LOAEL HQ to HI**
Copper	NC	--
Lead	NC	--
Mercury	NC	--
Total LPAHs	NC	--
Total HPAHs	NC	--
Dieldrin	-0.005	0.00
Total DDx	0.506	1.56
Total PCBs	18.53	57.16
Dioxin TEQ-Bird	13.38	41.28
HI =	**32.42**	**100.0**

Data Sources:
a = Table 5-1 CBR-Based Hazard Quotients for Estimated Fish Embryo Tissue - Generic Fish in Attachment 5 of the Louis Berger et al. (2014) Appendix D Risk Assessment
b = Table 5-3 Summary of Biomagnification Factors for Gull Embryo Tissue in Attachment 5 of the Louis Berger et al. (2014) Appendix D Risk Assessment
c = Table 4-4 TEQ Factors for Dioxin/Furans and Dioxin-like PCB Congeners in the BERA in Attachment 5 of the Louis Berger et al. (2014) Appendix D Risk Assessment
d = Lipids obtained from average American eel/white perch percent lipid in Lower Passaic River samples
e = TRVs from Table 6-1 Summary of Selected Critical Body Residue Values for Estuarine Macroinvertebrate, Fish and Avian Embryo Tissue in Attachment 6 of the Louis Berger et al. (2014) Appendix D Risk Assessment
f = Background EPCs based on empirical data for generic fish that include American eel, brown bullhead, carp, channel catfish, northern pike, smallmouth bass, white perch, and white sucker
g = Average lipid value for the generic fish collected above Dundee Dam

Notes:
Calculations based on approach used in in Attachment 5, Table 5-4 of Appendix D of the FFS (Louis Berger et al. 2014).
Negative values for Incremental HQs mean that background > Site

Acronyms:
COC = contaminant of interest
BERA - Baseline Ecological Risk Assessment
BMF - biomagnification factor
DDx = sum of DDD, DDE, and DDT.
FFS - Focused Feasibility Study
HI - hazard index
HPAHs = high-molecular polycyclic aromatic hydrocarbons
HQ - hazard quotient
LOAEL - Lowest observed adverse effect level
LPAHs = low-molecular polycyclic aromatic hydrocarbons
NC = not calculated
PCB = polychlorinated biphenyl
RM - River Mile
TEF - toxic equivalency factor
TEQ - toxic equivalent
TRV = toxicity reference value
ww = wet weight

References:
The Louis Berger Group. 2014 Focused Feasibility Study Report for the Lower Eight Miles of the Lower Passaic River. Produced in conjunction with Battelle, HDR, and HydroQual. Prepared for the U.S. Environmental Protection Agency, Region 2 and U.S. Army Corps of Engineers, Kansas City Division.

Table A-11 Lower Passaic River Study Area OU2 Fish Dietary Exposure Modeling Parameters, Calculations, and Results.

COC	Prey					Sediment		Dose		TRV			HQ	
	$C_{prey\ 1}$	$C_{prey\ 2}$	$C_{prey\ 3}$	Final $C_{prey,ww}$	Units	$C_{sed,dw}$	Units	Dose	Units	NOAEL	LOAEL	Units	NOAEL	LOAEL
Mummichog/forage fish	Worms (all)	NA	NA			Sediment, mudflats (all)								
Copper	11.00	-	-	11.0	mg/kg	220	mg/kg	0.908	mg/kg bw/day	1	2	mg/kg bw/day	0.91	0.45
Lead	10.2	-	-	10.2	mg/kg	320	mg/kg	0.976	mg/kg bw/day	134	--	mg/kg bw/day	0.0073	NC
White perch	Worms (all)	Blue crab	Fish (≤ 11 cm)			Sediment, sitewide								
Copper	11.00	24.00	3.1	11.8	mg/kg	170	mg/kg	0.969	mg/kg bw/day	1	2	mg/kg bw/day	0.97	0.48
Lead	10.2	0.37	2.2	7.53	mg/kg	240	mg/kg	0.714	mg/kg bw/day	134	--	mg/kg bw/day	0.005	NC
Channel catfish	Worms (all)	Blue crab	Fish (≤ 13 cm)			Sediment, sitewide								
Copper	11.00	24.00	3.3	8.57	mg/kg	170	mg/kg	0.585	mg/kg bw/day	1	2	mg/kg bw/day	0.6	0.29
Lead	10.2	0.37	2.8	6.75	mg/kg	240	mg/kg	0.565	mg/kg bw/day	134	--	mg/kg bw/day	0.004	NC
American eel - Small (< 50 cm)	Worms (all)	Blue crab	Fish (≤ 13 cm)			Sediment, sitewide								
Copper	11.00	24.00	3.3	11.5	mg/kg	170	mg/kg	1.034	mg/kg bw/day	1	2	mg/kg bw/day	1.03	0.52
Lead	10.2	0.37	2.8	8.48	mg/kg	240	mg/kg	0.850	mg/kg bw/day	134	--	mg/kg bw/day	0.006	NC
American eel - Large (> 50 cm)	Worms (all)	Blue crab	Fish (≤ 20 cm)			Sediment, sitewide								
Copper	11.00	24.00	4.8	11.8	mg/kg	170	mg/kg	0.718	mg/kg bw/day	1	2	mg/kg bw/day	0.7	0.36
Lead	10.2	0.37	2.1	4.50	mg/kg	240	mg/kg	0.368	mg/kg bw/day	134	--	mg/kg bw/day	0.003	NC
Largemouth bass	Worms (all)	Blue crab	Fish (≤ 13 cm)			Sediment, sitewide								
Copper	11.00	24.00	3.3	6.14	mg/kg	170	mg/kg	0.449	mg/kg bw/day	1	2	mg/kg bw/day	0.4	0.22
Lead	10.2	0.37	2.8	3.30	mg/kg	240	mg/kg	0.262	mg/kg bw/day	134	--	mg/kg bw/day	0.002	NC
Common Carp	Worms (FW sp. >RM4)	Blue crab	Fish (≤ 11 cm)			Sediment, sitewide								
Copper	11.00	24.00	3.1	13.1	mg/kg	170	mg/kg	0.743	mg/kg bw/day	1	2	mg/kg bw/day	0.7	0.37
Lead	10.2	0.37	2.2	8.45	mg/kg	240	mg/kg	0.638	mg/kg bw/day	134	--	mg/kg bw/day	0.005	NC
White Sucker	Worms (all)	Blue crab	na			Sediment, sitewide								
Copper	11.00	24.00	-	12.3	mg/kg	170	mg/kg	0.773	mg/kg bw/day	1	2	mg/kg bw/day	0.8	0.39
Lead	10.2	0.37	-	9.22	mg/kg	240	mg/kg	0.689	mg/kg bw/day	134	--	mg/kg bw/day	0.005	NC
White Catfish	Worms (all)	Blue crab	Fish (≤ 13 cm)			Sediment, sitewide								
Copper	11.00	24.00	3.3	8.57	mg/kg	170	mg/kg	0.591	mg/kg bw/day	1	2	mg/kg bw/day	0.6	0.30
Lead	10.2	0.37	2.8	6.75	mg/kg	240	mg/kg	0.570	mg/kg bw/day	134	--	mg/kg bw/day	0.004	NC
Smallmouth Bass	Worms (FW sp. >RM4)	Blue crab	Fish (≤ 13 cm)			Sediment, sitewide								
Copper	11.00	24.00	3.3	6.14	mg/kg	170	mg/kg	0.412	mg/kg bw/day	1	2	mg/kg bw/day	0.4	0.21
Lead	10.2	0.37	2.8	3.30	mg/kg	240	mg/kg	0.240	mg/kg bw/day	134	--	mg/kg bw/day	0.002	NC
Northern Pike	NA	Blue crab	Fish (≤ 20 cm)			Sediment, sitewide								
Copper	-	24.00	4.8	6.72	mg/kg	170	mg/kg	0.278	mg/kg bw/day	1	2	mg/kg bw/day	0.3	0.14
Lead	-	0.37	2.1	1.93	mg/kg	240	mg/kg	0.095	mg/kg bw/day	134	--	mg/kg bw/day	0.001	NC

Average HQs

COC	NOAEL	LOAEL
Mummichog/forage fish		
Copper	0.91	0.45
Lead	0.01	0.00
Generic Fish		
Copper	0.60	0.30
Lead	0.003	0.00

Dietary dose (mg/kg bw/d) = (([Cprey*FIR] + [Csed*SIR])/bw)*SUF

Mummichog				
FIR (kg ww/day)	0.00019	Worms (all)		100%
SIR (kg dw/day)	0.0000037	na		-
BW (kg)	0.0032	na		-
SUF	1	Sediment, mudflats (all)		
White Perch				
FIR (kg ww/day)	0.0041	Worms (all)		70%
SIR (kg dw/day)	0.000041	Blue crab		0.15
BW (kg)	0.057	Fish (≤ 11 cm)		0.15
SUF	1	Sediment, sitewide		
Channel Catfish				
FIR (kg ww/day)	0.036	Worms (freshwater sp. >RM4)		0.55
SIR (kg dw/day)	0.00073	Blue crab		0.05
BW (kg)	0.74	Fish (≤ 13 cm, above RM 4)		0.4
SUF	1	Sediment, sitewide		
American eel - Small (< 50 cm)				
FIR (kg ww/day)	0.0025	Worms (all)		0.8
SIR (kg dw/day)	0.000025	Blue crab		0.1
BW (kg)	0.032	Fish (≤ 13 cm)		0.1
SUF	1	Sediment, sitewide		
American eel - Large (> 50cm)				
FIR (kg ww/day)	0.024	Worms (all)		0.35
SIR (kg dw/day)	0.00024	Blue crab		0.25
BW (kg)	0.45	Fish (≤ 20 cm)		0.4
SUF	1	Sediment, sitewide		
Largemouth bass				
FIR (kg ww/day)	0.0054	Worms (freshwater sp. >RM4)		0.1
SIR (kg dw/day)	0.000011	Blue crab		0.1
BW (kg)	0.078	Fish (≤ 13 cm, above RM 4)		0.8
SUF	1	Sediment, sitewide		
Common Carp				
FIR (kg ww/day)	0.11	Worms (freshwater sp. >RM4)		0.82
SIR (kg dw/day)	0.0033	Blue crab		0.17
BW (kg)	2.7	Fish (≤ 11 cm, above RM 4)		0.01
SUF	1	Sediment, sitewide		
White Sucker				
FIR (kg ww/day)	0.039	Worms (freshwater sp. >RM4)		0.9
SIR (kg dw/day)	0.00077	Blue crab		0.1
BW (kg)	0.79	na		-
SUF	1	Sediment, sitewide		
White Catfish				
FIR (kg ww/day)	0.037	Worms (all)		0.55
SIR (kg dw/day)	0.00074	Blue crab		0.05
BW (kg)	0.75	Fish (≤ 13 cm)		0.4
SUF	1	Sediment, sitewide		
Smallmouth Bass				
FIR (kg ww/day)	0.0089	Worms (freshwater sp. >RM4)		0.1
SIR (kg dw/day)	0.000018	Blue crab		0.1
BW (kg)	0.14	Fish (≤ 13 cm, above RM 4)		0.8
SUF	1	Sediment, sitewide		
Northern Pike				
FIR (kg ww/day)	0.11	na		-
SIR (kg dw/day)	0.00023	Blue crab		0.1
BW (kg)	2.8	Fish (≤ 20 cm , above RM 4)		0.9
SUF	1	Sediment, sitewide		

Notes:
Sediment EPCs are from Table 4-1 in Berger et al. (2014) Appendix D Risk Assessment
Prey and sediment EPCs were calculated from Site tissue data in Windward (in press-a,-b)
EPCs are 95UCLs calculated using ProUCL

Acronyms:
BW = body weight
COC = contaminant of concern
EPC = exposure point concentration
FIR = food ingestion rate
FW = freshwater
HQ = hazard quotient
LOAEL = lowest observed adverse effect level
NA = not available
NC = not calculated
NOAEL = no observed adverse effect level
RM = river mile
SIR = sediment ingestion rate
SUF = site use factor
TRV = toxicity reference value

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Table A-12 Background Fish Dietary Exposure Modeling Parameters, Calculations, and Results.

COC	Prey					Sediment		Dose		TRV			HQ	
	$C_{prey\ 1}$	$C_{prey\ 2}$	$C_{prey\ 3}$	Final $C_{prey,ww}$	Units	$C_{sed,dw}$	Units	Dose	Units	NOAEL	LOAEL	Units	NOAEL	LOAEL
Mummichog/forage fish	Worms (all)	NA	NA			Sediment, sitewide								
Copper	1.47	-	-	1.47	mg/kg	136.3	mg/kg	0.245	mg/kg bw/day	1	2	mg/kg bw/day	0.245	0.123
White perch	Worms (all)	Blue crab	Fish (≤ 11 cm)			Sediment, sitewide								
Copper	1.47	7.5	1.49	2.38	mg/kg	136.3	mg/kg	0.269	mg/kg bw/day	1	2	mg/kg bw/day	0.269	0.135
Channel catfish	Worms (all)	Blue crab	Fish (≤ 13 cm)			Sediment, sitewide								
Copper	1.47	7.5	1.49	1.78	mg/kg	136.3	mg/kg	0.221	mg/kg bw/day	1	2	mg/kg bw/day	0.221	0.111
American eel - Small (< 50 cm)	Worms (all)	Blue crab	Fish (≤ 13 cm)			Sediment, sitewide								
Copper	1.47	7.5	1.49	2.08	mg/kg	136.3	mg/kg	0.269	mg/kg bw/day	1	2	mg/kg bw/day	0.269	0.134
American eel - Large (> 50 cm)	Worms (all)	Blue crab	Fish (≤ 20 cm)			Sediment, sitewide								
Copper	1.47	7.5	1.49	2.99	mg/kg	136.3	mg/kg	0.232	mg/kg bw/day	1	2	mg/kg bw/day	0.232	0.116
Largemouth bass	Worms (all)	Blue crab	Fish (≤ 13 cm)			Sediment, sitewide								
Copper	1.47	7.5	1.49	2.09	mg/kg	136.3	mg/kg	0.164	mg/kg bw/day	1	2	mg/kg bw/day	0.164	0.082
Common Carp	Worms (FW sp. >RM4)	Blue crab	Fish (≤ 11 cm)			Sediment, sitewide								
Copper	1.47	7.5	1.49	2.50	mg/kg	136.3	mg/kg	0.268	mg/kg bw/day	1	2	mg/kg bw/day	0.268	0.134
White Sucker	Worms (all)	Blue crab	na			Sediment, sitewide								
Copper	1.47	7.5	1.49	2.08	mg/kg	136.3	mg/kg	0.235	mg/kg bw/day	1	2	mg/kg bw/day	0.235	0.118
White Catfish	Worms (all)	Blue crab	Fish (≤ 13 cm)			Sediment, sitewide								
Copper	1.47	7.5	1.49	1.78	mg/kg	136.3	mg/kg	0.222	mg/kg bw/day	1	2	mg/kg bw/day	0.222	0.111
Smallmouth Bass	Worms (FW sp. >RM4)	Blue crab	Fish (≤ 13 cm)			Sediment, sitewide								
Copper	1.47	7.5	1.49	2.09	mg/kg	136.3	mg/kg	0.150	mg/kg bw/day	1	2	mg/kg bw/day	0.150	0.075
Northern Pike	NA	Blue crab	Fish (≤ 20 cm)			Sediment, sitewide								
Copper	1.47	7.5	1.49	2.09	mg/kg	136.3	mg/kg	0.093	mg/kg bw/day	1	2	mg/kg bw/day	0.093	0.047

Average HQs

COC	NOAEL	LOAEL
Mummichog/forage fish		
Copper	0.25	0.12
Generic Fish		
Copper	0.21	0.11

Dietary dose (mg/kg bw/d) = (([Cprey*FIR] + [Csed*SIR])/bw)*SUF

Mummichog			
FIR (kg ww/day)	0.00019	Worms (all)	1
SIR (kg dw/day)	0.0000037	na	-
BW (kg)	0.0032	na	-
SUF	1		
American eel - Large (> 50cm)			
FIR (kg ww/day)	0.024	Worms (all)	0.35
SIR (kg dw/day)	0.00024	Blue crab	0.25
BW (kg)	0.45	Fish (≤ 20 cm)	0.4
SUF	1		
White Catfish			
FIR (kg ww/day)	0.037	Worms (all)	0.55
SIR (kg dw/day)	0.00074	Blue crab	0.05
BW (kg)	0.75	Fish (≤ 13 cm)	0.4
SUF	1		
White Perch			
FIR (kg ww/day)	0.0041	Worms (all)	0.7
SIR (kg dw/day)	0.000041	Blue crab	0.15
BW (kg)	0.057	Fish (≤ 11 cm)	0.15
SUF	1		
Largemouth Bass			
FIR (kg ww/day)	0.0054	Worms (freshwa	0.1
SIR (kg dw/day)	0.000011	Blue crab	0.1
BW (kg)	0.078	Fish (≤ 13 cm, a	0.8
SUF	1		
Smallmouth Bass			
FIR (kg ww/day)	0.0089	Worms (freshwa	0.1
SIR (kg dw/day)	0.000018	Blue crab	0.1
BW (kg)	0.14	Fish (≤ 13 cm, a	0.8
SUF	1		
Channel Catfish			
FIR (kg ww/day)	0.036	Worms (freshwa	0.55
SIR (kg dw/day)	0.00073	Blue crab	0.05
BW (kg)	0.74	Fish (≤ 13 cm, a	0.4
SUF	1		
Common Carp			
FIR (kg ww/day)	0.11	Worms (freshwa	0.82
SIR (kg dw/day)	0.0033	Blue crab	0.17
BW (kg)	2.7	Fish (≤ 11 cm, a	0.01
SUF	1		
Northern Pike			
FIR (kg ww/day)	0.11	na	-
SIR (kg dw/day)	0.00023	Blue crab	0.1
BW (kg)	2.8	Fish (≤ 20 cm , a	0.9
SUF	1		
American eel - Small (< 50 cm)			
FIR (kg ww/day)	0.0025	Worms (all)	0.8
SIR (kg dw/day)	0.000025	Blue crab	0.1
BW (kg)	0.032	Fish (≤ 13 cm)	0.1
SUF	1	Sediment, sitewide	
White Sucker			
FIR (kg ww/day)	0.039	Worms (freshwa	0.9
SIR (kg dw/day)	0.00077	Blue crab	0.1
BW (kg)	0.79	na	-
SUF	1	Sediment ≥ RM 4	

Notes:
Sediment EPCs are from Table 4-1 in Berger et al. (2014) Appendix D Risk Assessment
Prey and sediment EPCs were calculated from Site tissue data in Windward (in press-a,-b)
EPCs are 95UCLs calculated using ProUCL

Acronyms:
BW = body weight
COC = contaminant of concern
EPC = exposure point concentration
FIR = food ingestion rate
FW = freshwater
HQ = hazard quotient
LOAEL = lowest observed adverse effect level
NA = not available
NC = not calculated
NOAEL = no observed adverse effect level
RM = river mile
SIR = sediment ingestion rate
SUF = site use factor
TRV = toxicity reference value

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Table A-13 Benthic Worm Bioaccumulation Model Development for Use in Estimating Background Worm Tissue Concentrations

Species	Tissue SampleID	Sediment SampleID	Parameter	Detected Pair	Worm				Sediment				Ratio
					Result (ww)	Unit (ww)	Qual	Detect	Result (dw)	Unit (dw)	Qual	Detect	Tissue/Sediment
Estuarine worm	LPRT01A-NV	LPRT01A	Copper	Yes	1.6	mg/kg	J	Yes	122	mg/kg	J	Yes	0.013
Estuarine worm	LPRT01F-NV	LPRT01F	Copper	Yes	1.3	mg/kg	J	Yes	123	mg/kg	J	Yes	0.011
Estuarine worm	LPRT02E-NV	LPRT02E	Copper	Yes	1.2	mg/kg	J	Yes	163	mg/kg	J	Yes	0.007
Estuarine worm	LPRT04B-NV	LPRT04B	Copper	Yes	1.2	mg/kg	J	Yes	165	mg/kg	J	Yes	0.007
Estuarine worm	LPRT06C-NV	LPRT06C	Copper	Yes	1.5	mg/kg	J	Yes	95.2	mg/kg		Yes	0.016
Average Copper Tissue/Sediment Ratio for Estuarine Species located RM 0 to RM 8.3 =													0.011

Predicting background worm tissue concentrations

Description	Copper (mg/kg)	Ratio
Sediment 95UCL (background)	136.3	-
Ratio ave worm/sed (co-located) by sample	-	0.011
Predicted bkg worm using site co-located ratio	1.47	-

Summary of background fish prey EPCs

Description	Copper (mg/kg)
Max value for fish < 11 cm (empirical - silver shiner max)	1.49
Max value for fish < 13 cm (empirical - silver shiner max))	1.49
Max value for fish < 20 cm (empirical - silver shiner max))	1.49

Notes:
Ratio of estuarine worm tissue concentrations to co-located tissue from < RM 8.3 used to develop relationship between invertebrate tissue and sediment; ratio applied to empirical background data for sediment
Co-located worm and tissue data; used estuarine worm tissue data from RM 0 to RM 8.3
Empirical background sediment data co-located with worm data from LPRSA BERA (includes all surface sediment data above Dundee Dam; EPCs calculated using ProUCL
Background surface sediment data derived using ProUCL 5.1 software
Three background fish (silver shiner, banded killifish, and silver shiner) met the criteria of < 20 cm, < 13 cm, and < 11cm
Background EPCs for prey fish are maximum values for that size category (silver shiner) from Windward (in prep-a); limited data therefore could not calculate UCL and maximum concentration used

Acronyms:
dw = dry weight
EPC = exposure point concentration
Qual = qualifier
RM = river mile
UCL = upper confidence limit
ww = wet weight

Addendum to Allocation Protocol

Prepared by Allocator in Consultation with Participating Allocation Parties
May 20, 2019

Principles to be used by the Allocation Team in estimating the mass of a COC discharged from an Allocation Party facility in absence of credible information

As noted in Step 2, Section 2(e) of the Allocation Protocol:

> "Where the Allocator determines that a lack or the nature of available information does not allow an objective determination of the mass of a COC discharged from an Allocation Party facility, the Allocator may take additional measures to obtain relevant information, including requesting additional information from the Allocation Party or requesting the assistance of EPA in obtaining additional data. Should these measures, if taken, not resolve the lack or nature of available information, the Allocator may estimate such mass utilizing a set of assumptions established in consensus with the Participating Allocation Parties, which assumptions will be described in the Final Allocation Recommendation Report. If used in recommending an Allocation Party's share, the Allocator will explain which assumptions were relied upon and how they factored into his analysis. Such assumptions may include, but not be limited to:
>
> (1) Standard operations of similar industrial facilities;
> (2) Changes in industrial operations over time;
> (3) Onsite fate and transport of COCs; and
> (4) Strength of available information."

The following is an overview of the additional measures, established in consensus with the Participating Allocation Parties (PAPs), which will be taken by the Allocation Team to obtain additional relevant information to resolve the lack or nature of available information necessary for conduct of the Allocation. These measures can be applied to determine the use, discharge, and/or mass of a COC discharged from an Allocation Party facility for purposes of the Allocation.

The Allocation Team will adhere to the following principles in seeking and utilizing such additional relevant information:

- The Allocator will make a determination on the need for additional information to resolve deficiencies due to the lack or nature of available information at or near the time that the Preliminary Facility Data Reports are made available for review by PAPs;

- Additional information determined by the Allocator as beneficial to resolving the lack or nature of available information may, at the sole discretion of the Allocator, be requested of a PAP, either by (1) a request for voluntary submission or

commitment to provide information with the PAP's expert report(s), or (2) through request to EPA for issuance of a 104(e) requiring submission of information – The Allocation Team will not undertake independent efforts to obtain such additional information;

- PAPs requested to conduct a search for additional information will adhere to a reasonable due diligence standard and schedule for information gathering in support of the Allocation as specified in the Allocation Guide;

- Any such request for additional information will include an explanation of how such information will be utilized to resolve the lack or nature of available information, including as relevant the nature of reasonable inferences to be drawn through use of the obtained information;

- The Allocator will rely on the most reliable analytical approaches in establishing inferences for use in determining an appropriate equitable allocated share - For example, if a facility has data for some but not all years of operation, such data may be more reliable to fill data gaps than relying on inferences based on the operations of other similar facilities;

- The Allocator will ensure consistency in his application of inferences – For example, if an inference is drawn regarding the fate and transport of a COC based on the nature of the COC or waterway via which it is transported, the same inference will be applied for other facilities discharging the same COC or transporting via the same waterway; and

- The Allocator will provide a succinct explanation of what inferences, if any, were utilized in the determination of an Allocation Party's allocated share as early as possible, but no later than issuance of the Preliminary Allocation Recommendation Report.

Sources of additional data requested to resolve the lack or nature of available information may include, but are not limited to, the following sources.

1. Aerial photographs
2. Sanborn Fire Insurance Maps
3. The following program files may be useful where it is clear that a party is regulated by an NJDEP program but has not provided documents related to such regulation:
    a. Site Remediation Program Files
    b. Solid and Hazardous Waste Files
    c. Water Quality/NJPDES Files
    d. Pollution Prevention – Right to Know & Release and Pollution Prevention Reports
    e. Air Quality Reports

4. Similarly, it may be that the following EPA program files may assist in determining how to fill data gaps about facility operations:
    a. Toxic Release Inventory
    b. Enforcement and Compliance History Online (ECHO)
    c. RCRAInfo
5. Passaic Valley Sewerage Commission Source Determination Reports
6. Other resources that may be useful in addressing data gaps include:
    a. Interstate Sanitation Commission Historic Reports (www.iec.nynjct.org/archive.htm)
    b. Office of Patents and Trademarks (www.uspto.gov/trademarks/index.jsp)
    c. EPA Industry Sector Notebook (archive.epa.gov/compliance/resources/publications/assistance/sectors/web/html/index-3.html)
    d. National archives (www.archives.gov/index.html)
    e. War Production Database (www.archives.gov/index.html)
    f. Hoovers Online (www.hoovers.com)
    g. National Response Center (www.nrc.uscg.mil)
    h. Securities and Exchange Commission (www.sec.gov/edgar/searchedgar/companysearch.html)
7. Kirk-Othmer Encyclopedia of Chemical Technology
8. Trade Literature
9. Killam’s Heavy Metal Study from 1978

ATTACHMENT I

LIST OF PARTICIPATING ALLOCATION PARTIES

Diamond Alkali Superfund Site – Operable Unit 2
Participating Allocation Parties

1. Alliance Chemical, Inc.
2. Arkema, Inc. (Legacy Site Services)
3. Ashland Inc.
4. Atlantic Richfield Company
5. Atlas Refining, Inc.
6. BASF Catalysts LLC
7. BASF Corporation
8. Benjamin Moore & Company
9. Berol Corporation
10. Campbell Foundry Company
11. Canning Gumm LLC (c/o MacDermid, Inc.)
12. CBS Corporation (n/k/a ViacomCBS Inc.)
13. Celanese Ltd. (CNA Holdings LLC) – Doremus Ave
14. Chevron Environmental Management Company for itself and on behalf of Texaco Inc. and TRMI-H LLC.
15. Coats & Clark, Inc.
16. Congoleum Corporation
17. Conopco, Inc., d/b/a Unilever (as successor to CPC/Bestfoods, former parent ofPenick Corporation)
18. Cooper Industries LLC
19. Covanta Essex Company
20. Curtiss-Wright Corporation
21. DII Industries, LLC (c/o Haliburton)
22. Elan Chemical Co., Inc.
23. El Paso (EPEC Polymers, Inc. on behalf of itself and EPEC Oil Co. Liquidating Trust)
24. EnPro Holdings, Inc. (successor by merger to Coltec Industries Inc.)
25. Essex Chemical Corporation
26. Everett Smith Group
27. Franklin-Burlington Plastics, Inc.
28. Garfield Molding Company, Inc.
29. General Electric Company
30. Givaudan Fragrances Corporation
31. Goodrich Corp. for itself and for Kalama Specialty Chemicals, Inc.
32. Goody Products, Inc. on behalf of itself and Newell Brands Inc. (f/k/a Newell Rubbermaid Inc.)
33. Hexcel Corporation
34. Hoffmann-LaRoche, Inc.
35. Honeywell International, Inc.

36. ISP Chemicals LLC
37. Kearny Smelting
38. L3Harris Technologies, Inc., successor in interest to Exelis Inc., successor in interest to the defense business of ITT Corporation
39. Leemilt's Petroleum, Inc. (successor to Power Test of New Jersey, Inc.), on its behalf and on behalf of Power Test Realty Company Limited Partnership and Getty Properties Corp., the General Partner of Power Test Realty Company Limited Partnership
40. Legacy Vulcan Corporation (f/k/a Vulcan Materials Company)
41. National Standard LLC
42. Neu Holdings (Eden Wood Corporation)
43. Newark Morning Ledger Co.
44. Nokia of America Corporation (Lucent Technologies Inc. / Alcatel-Lucent USA Inc.)
45. Okonite Company, Inc.
46. Otis Elevator Company
47. Pabst Brewing Company, LLC
48. Passaic Pioneer Properties Co.
49. Pharmacia Corporation (f/k/a Monsanto Company)
50. Pitt-Consol Chemical Company
51. PPG Industries, Inc.
52. Public Service Electric and Gas Company
53. Purdue Pharma Technologies, Inc.
54. Quality Carriers, Inc. as successor to Chemical Leaman Tank Lines, Inc. and Quality Carriers, Inc.'s corporate affiliates and parents
55. Revere Smelting and Refining Corporation
56. Safety-Kleen Envirosystems Company by McKesson, and McKesson Corporation
57. Sequa Corporation
58. Spectraserv, Inc.
59. Stanley Black & Decker, Inc. (f/k/a The Stanley Works)
60. STWB Inc. (c/o Bayer Corporation)
61. Sun Chemical Corporation
62. Tate & Lyle Ingredients Americas, Inc.
63. Teval Corporation
64. Textron Inc.
65. TFCF America, Inc. (f/k/a 21st Century Fox America, Inc.)
66. The Hartz Consumer Group, Inc., for the Hartz Mountain Corporation
67. The Newark Group, Inc.
68. The Sherwin-Williams Company
69. Tiffany and Company